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THIS RESOURCE BOOK OF ACTIVITIES WAS WRITTEN FOR TEACHERS OF GRADES K-6, TO HELP THEM INTEGRATE AEROSPACE SCIENCE WITH THE REGULAR LEARNING EXPERIENCES OF THE CLASSROOM. SUGGESTIONS ARE MADE FOR INTRODUCING AEROSPACE CONCEPTS INTO THE VARIOUS SUBJECT FIELDS SUCH AS LANGUAGE ARTS, MATHEMATICS, PHYSICAL EDUCATION, SOCIAL STUDIES, AND OTHERS. SUBJECT CATEGORIES ARE (1) DEVELOPMENT OF FLIGHT, (2) PIONEERS OF THE AIR (BIOGRAPHY), (3) ARTIFICIAL SATELLITES AND SPACE PROBES, (4) MANNED SPACE FLIGHT, (5) THE VASTNESS OF SPACE, AND (6) FUTURE SPACE VENTURES. SUGGESTIONS ARE MADE THROUGHOUT FOR USING THE MATERIAL AND THEMES FOR DEVELOPING INTEREST IN THE REGULAR LEARNING EXPERIENCES BY INVOLVING STUDENTS IN AEROSPACE ACTIVITIES. INCLUDED ARE LISTS OF SOURCES OF INFORMATION SUCH AS (1) BOOKS, (2) PAMPHLETS, (3) FILMS, (4) FILMSTRIPS, (5) MAGAZINE ARTICLES, (6) CHARTS, AND (7) MODELS. GRADE LEVEL APPROPRIATENESS OF THESE MATERIALS IS INDICATED. (DH)

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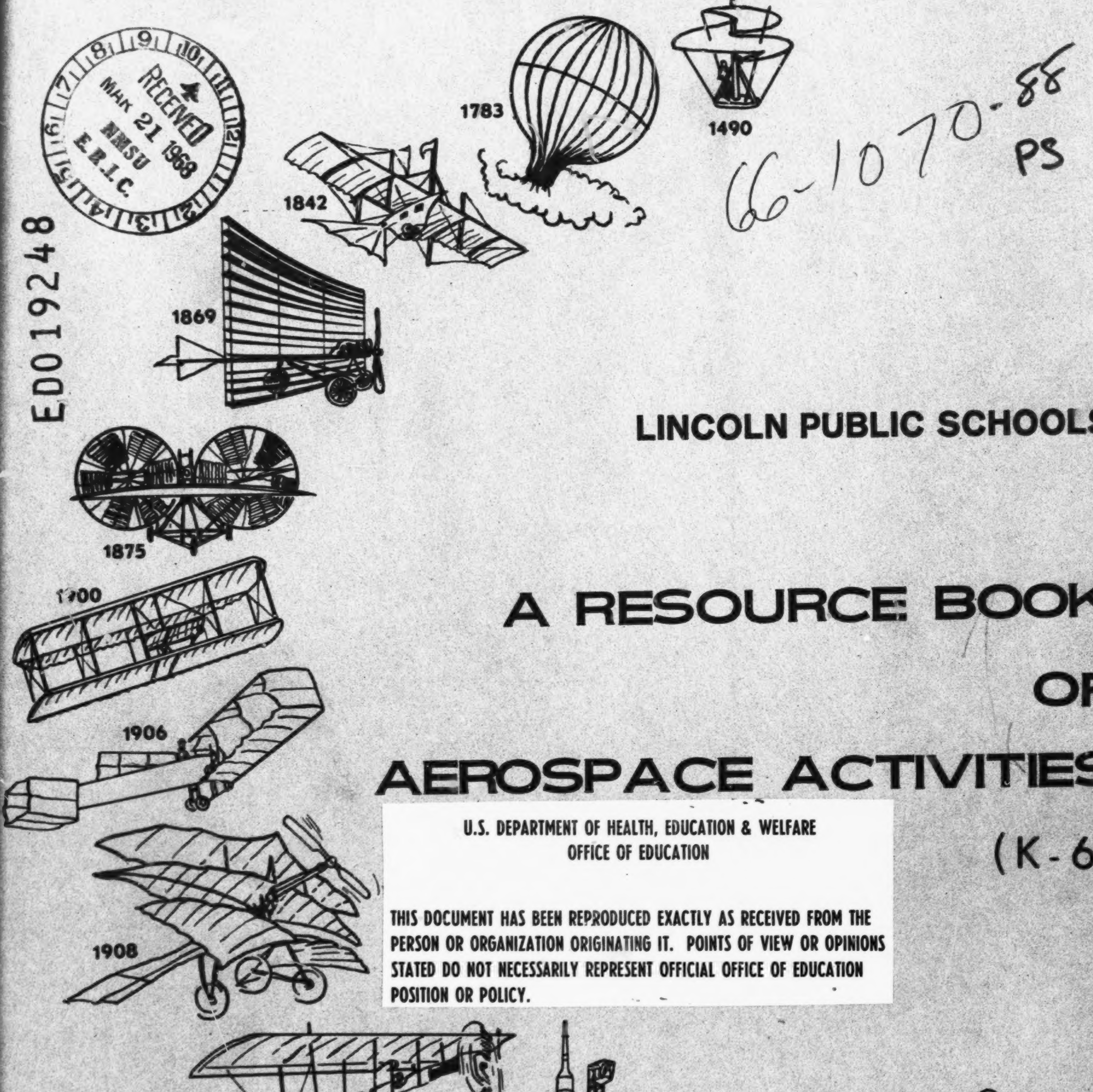
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LINCOLN PUBLIC SCHOOLS

A RESOURCE BOOK OF AEROSPACE ACTIVITIES

(K-6)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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A RESOURCE BOOK OF AEROSPACE ACTIVITIES
(K - 6)

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INTRODUCTION

A Resource Book of Aerospace Activities was written to help teachers integrate aerospace content with the regular learning experiences in the classroom. The activities contained in this volume are grouped by subject headings as follows: Development of Flight, Pioneers of the Air (biography), Artificial Satellites and Space Probes; Manned Space Flight, The Vastness of Space, and Future Space Ventures. Poetry related to flight and space travel is contained in Appendix A. The individual activities in these areas contain suggestions for bringing aerospace concepts into language arts, mathematics, physical education, social studies, and many other subjects.

A teacher using these activities will find many suggestions for sparking children's interest in everyday learning tasks. A routine arithmetic drill, for instance, might capture the pupils' imagination if it concerns some of the mathematical problems of space travel. Interest in creative writing might be sparked by having children write about space travel or about what we might discover on the other planets. Using the universe or space travel as a theme might help inspire artistic creativity in children.

Each activity is accompanied by lists of media appropriate to the subject. Books, pamphlets, films, filmstrips, magazine articles, charts and models are included in these lists. Grade levels for which these materials are most suitable are indicated by the following code: p (primary, K-3);i(intermediate, 4-6); and t (teacher--includes junior high, senior high and adult).

The material can be adapted for use in all of the elementary grades to stimulate students' interest in and understanding of the scientific and social advancements being made by mankind as a result of aerospace research and development.

Aerospace Activities Committee, Summer, 1966

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DEVELOPMENT OF FLIGHT

DEVELOPMENT OF FLIGHT

OVERVIEW

Flying has had a greater impact on the world than any other mode of transportation. The children of today must have an awareness and appreciation of the history, practical effects, and future potential of the aerospace industry. Both present and future generations must be able to understand and apply aeronautical principles, if we as a country are to maintain our air power position. Young men and women must be informed about the number and variety of careers which are available in this ever-broadening field.

We live in a world of continuous change. The miracle of yesterday is the commonplace of today. This unit was designed to promote interest in the past as a stepping stone to progress in the future. Our dreams and hopes will one day become the realities of life for future generations.

TABLE I

THE DEVELOPMENT OF FLIGHT

The following chronological listing of dates and names summarizes the most significant events in the development of flight.

1232 - The first solid-fuel rocket was developed by the Chinese.

1783 - Joseph Michel Montgolfier and Jacques Etienne Montgolfier designed and flew the first balloon. J. A. C. Charles, a Franchman, built and launched the first hydrogen balloon.

1784 - Marie Thible, of France, was the first woman to ascend in a balloon.

1793 - The first balloon flight in the United States was made by Jean Blanchard.

1804 - Sir William Congreve, of England, developed solid-fuel rockets for military purposes.

1835 - America's first airmail flight was made from Cincinnati, Ohio, to Waverly, Ohio by balloon.

1846 - William Hale developed a guidance system for a rocket.

1852 - Henri Giffard, of France, made the first dirigible flight.

1883 - John Montgomery made the first successful glider flight in the United States.

1891 - Otto Lilienthal developed and flew his gliders.

1903 - Wilbur and Orville Wright flew the first mechanically powered heavier-than-air craft.

1904 - Captain Thomas Baldwin built the first American dirigible.

1907 - Paul Carnu, of France, became the first man to fly in a helicopter.

1909 - Louis Bleriot, of France, made the first monoplane flight over the English Channel.

1911 - Galbraith P. Rodgers made the first transcontinental flight across the United States in eighty-four days.

1914 - Tony Jannus flew the first scheduled airline flight. He flew daily between Tampa, Florida, and St. Petersburg, Florida.

1918 - The first restrictions in licensing pilots were established.

1919 - John Alcock and A.W. Brown, of England, made the first non-stop transatlantic crossing in sixteen hours and twelve minutes.

1926 - Admiral Richard E. Byrd and his pilot made the first flight over the North Pole.
Dr. Robert Goddard successfully fired the first liquid-fuel rocket.

1927 - Charles A. Lindbergh flew the first solo non-stop flight in a single-engine plane across the Atlantic. The time en route was thirty-three hours and thirty minutes.

1932 - Amelia Earhart was the first woman to fly solo across the Atlantic in a single-engine airplane.

1933 - Wiley Post made the first solo round-the-world flight in seven days, eighteen hours and forty-nine minutes.

1938 - The Civil Aeronautics Authority was formed.

1939 - Sikorsky designed and built the first practical helicopter.

1944 - The Germans fired the V-2 rocket.

1947 - Chuck Yeager flew faster than the speed of sound in the rocket-powered Bell X-1.

1953 - Jacqueline Cochran, of the United States, was the first woman to fly faster than sound.

1957 - Russia's Sputnik I orbited the earth.

1958 - The United States' Explorer I satellite orbited the earth.
The National Aeronautics and Space Administration was organized.
The Federal Aviation Agency was organized.

1960 - Echo I, the first balloon of our space program, was launched.

1961 - Russia's Yuri Gagarin made the first orbit of the earth.
Alan B. Shepard, of the United States, made our first manned sub-orbital space flight.

1962 - John Glenn made the first United States manned orbital space flight.

1963 - Valentina Tereshkova, of Russia, was the first woman to travel in space.

1965 - Virgil Grissom and John Young made the first two-man space flight.
Grissom was also the first person to be in space twice.
Aleksei Leonov, of Russia, was the first man to walk in space.
Ed White was the first American to walk in space.

1966 - United States was the first country to soft-land a craft, Surveyor I, on the moon.
Lunar Orbiter I orbited the moon and photographed future landing sites.

1966 - Lunar Orbiter II photographed the crater, Copernicus, in "the picture of the century."

1966 - Surveyor III made a soft landing on the moon; returned 6,315 pictures and took samples of the surface.

MAN'S DREAM

Topic

Man's early desire to fly

Background

Since the beginning of recorded history, there is evidence in man's drawings and folklore of his desire to fly. Since man himself could not fly he ascribed this prerogative to his gods. In ancient Greece, Phaeton, son of Helios, the sun god, drove the wild horses that pulled the sun chariot. The messenger of the gods, Mercury, had a winged helmet and winged sandals. The winged horse, Pegasus, was able to fly farther, higher, and faster than any bird. Others who could fly were Hermes, the Greek messenger with his winged sandals, the German Valkyrie who descended to battlefields on Earth and carried slain heroes to Valhalla, the Arabs with their flying carpets, and Sinbad the sailor and his Roc. There are countless other stories of magical flight.

According to Greek legend, the Athenian inventor, Daedalus, was the first man to fly. He and his son, Icarus, imprisoned on the island of Crete by King Minos, tried to escape by shaping wings of wax and bird feathers. During the flight, Icarus, bold and excited, flew too close to the sun, melting the wax on his wings, causing him to fall into the sea and drown. This body of water is still called the Icarian Sea.

Throughout the years man continued in his dream of flight. Hundreds of failures and disappointments only made him more determined to conquer the realm of the birds.

Vocabulary

Icarus
King Minos
legend
Mercury
mythology
Pegasus
Phaeton
Roc
Sinbad
Valkyrie

Suggested Activities

a. Make available the myths that are mentioned in the background. Discuss how imagination played an important part in the development of flight. Most reading books contain one or more stories on mythology with which this could be correlated.

b. After students have discussed several stories of flying by strange and magical means, have them write their own story about an imaginary flying conveyance.

c. Create a large mural representing the flight of Daedalus and Icarus. Incorporate three-dimensional materials, such as feathers, cloth, twigs, etc.

d. Have the class observe insects, moths, birds and butterflies in flight.

e. Find ways many of these characters of mythology are used in our advertising today.

f. Use the word "aero" from the Greek, meaning air or atmosphere. Add other word roots to "aero" to form compound English words such as aerobe, aerography, aerolite, aeromarines, aerophyte. Use a dictionary to look up the meaning and pronunciation of each word. Does the second part of each word come from Greek or Latin? Other word roots relating to aerospace which could be studied in a similar manner are: astro (star), auto (self), cycle (wheel), scope (view), and tele (far).

g. Dramatize a legend or myth concerning man's dream of flying. Select character parts. If the play is short, choose various casts. If it is to be produced for an audience, there may need to be committees for scenery, sound effects, costumes, programs.

h. Make puppets and plan a puppet show depicting a legend or myth.

Source Materials

Books

American Heritage History of Flight, New York: The American Heritage Pub. Co., 1962 i. t.
Cooke, David C., *Flights That Made History*, New York: G. P. Putnam's Sons, 1959 i. t.
Cooper, Margaret, *Inventions of Leonardo da Vinci*, New York: The MacMillan Co., 1965 t.
Highland, Harold, *The How and Why Wonder Book of Flight*, New York: Grosset and Dunlap, 1961 i.
Maizlish, Leon I., *Wonderful Wings--The Story of Aviation*, New York: Row, Peterson & Co., 1941 i. t.
Shippen, Katherine B., *A Bridle for Pegasus*, New York: Viking Press, 1951 i.
Warner, Rex, *Men and Gods*, New York: Random House, 1959 t.
White, Anne Terry, *Golden Treasury of Myths and Legends*, New York: Golden Press, 1959 t.

Record

All About Wheels and Wings

Film

Man in Flight, 30 min., Walt Disney Films, 800 Sonora Ave., Glendale California 91201

Pictures

Teach-A-Chart, #103, Eye Gate House Inc., Jamaica 35, New York, 18" x 24", 12 pts.

FLOATING THROUGH THE AIR WITH THE GREATEST OF EASE

Topic

Balloons

Background

In France there lived two brothers named Montgolfier who became interested in the reason why smoke rises. They realized that if they could catch some hot air, it might lift things into the air. In their early experiments, they filled paper bags with smoke from the fireplace. The bags rose and floated to the ceiling.

Using this principle, the two brothers built a large balloon out of paper lined with linen and filled it with hot air from a bonfire. The crowds that gathered that day in 1783 to watch the strange sight were amazed and frightened when the balloon rose six thousand feet.

This event was the first successful flight in history. After their success, the Montgolfiers began planning a flight to take men into the air. Animals were selected to make the next ascent to see if living things could survive a flight. The Montgolfiers hung a basket beneath one of their balloons and selected their first passengers--a rooster, a sheep, and a duck. In that same year the first men went up in a Montgolfier balloon. They were the young Frenchmen, Jean Francois Pilatre de Rozier and his friend, the Marquis d'Arlandes. Another man who made an ascent in a balloon that eventful year was Professor Charles. He sent up a bag filled with hydrogen instead of hot air. It fell into a village, and was attacked and destroyed by terrified peasants.

The balloon was an impractical means of transportation because it had no power and could not be guided. Ballooning however, led to the development of the dirigible, an airship driven by a powerful engine. Dirigibles, like balloons, were kept aloft by a gas that was lighter than air. Hydrogen was often used to inflate them but it was inflammable and explosive. In 1937, the hydrogen-filled dirigible, Hindenburg, caught fire and exploded over Lakehurst, New Jersey just as it was completing a voyage from Germany. After that disaster, most dirigibles used helium, a safer gas.

Balloons and dirigibles are still in limited use today for weather observations and advertising. Balloons are also being used in outer space. The Echo series of communications satellites are actually balloons in orbit around the earth.

Vocabulary

aeronaut
airship
ascend
balloonist
blimp
cosmic rays
descent
dirigible
exosphere
free flight
helium
hydrogen
ionosphere
sphere
stratosphere
troposhere

Suggested Activities

Read stories concerning early balloon flights. Illustrations such as those found in the American Heritage History of Flight would be very useful in creating an interest in balloons.

a. Have the children make model balloons as a class project. Inflate a large rubber balloon (cover with tissue paper and starch, if you prefer) and attach a basket (cut off milk carton) below it using yarn or string. Fasten the lines at the top of the balloon. This could also be done by individual students with smaller balloons.

b. Reports could be made relating the various uses of balloons in the past and present.

c. Children can make pictures illustrating early balloon flights. Use crayon, tempera, cut paper, or 3-D materials. A mural depicting ascending balloons can be an effective class activity.

d. Write a limerick (about balloons or balloonists) which might have appeared in 1783. Suggested beginning lines:
   1. There was a young man from Pa-ree....
   2. The balloonists ascended with ease.....

e. On a world map, mark countries where significant balloon flights have taken place. Use map pins to fasten a cut-out symbol which illustrates this accomplishment.

f. Make posters or a reference chart showing proportional layers of the atmosphere. Indicate record altitudes attained by balloons from 1873 to the present. Include both manned and unmanned balloons. A graph depicting their record ascensions could be superimposed on the representation of the atmosphere.

g. Have children make bubbles (over a source of heat) to show that hot air rises. You can use straws, embroidery hoops, etc. depending upon the size of bubbles you wish to make.
   Bubbles recipe: 1 part detergent
   5 parts distilled water
   1 part glycerine

h. To show how hot air rises, place a balloon over the mouth of a soft drink bottle which has been placed in a pan of water. Heat the water and watch the hot air rise and inflate the balloon.

i. Have children find out about gases that are lighter than air. What are some of their properties and practical uses for them?

j. Have the children release helium-filled balloons. Attach a light, waterproof plastic bag containing a self-addressed postal card to the balloon. After the cards are returned determine how far the balloons traveled and in what direction they went.

Source Materials

Books

American Heritage History of Flight, New York: Simon and Schuster, Inc., 1962 i. t.
Burchard, Peter, Balloons, New York: Macmillan Co., 1960 p. i.
Burchard, Peter, Balloons: From Paper Bags to Skyhooks, New York, 1960 p. i.
Cook, David, Dirigibles That Made History, New York: G. P. Putnam's Sons, 1962 t.
Douty, Esther, Ball in the Sky, New York: Holt, Rinehart and Winston, Inc., 1956 i.
Du Bois, William Pene, The Twenty One Balloons, New York: Viking Press, 1947 i. t.
Fundamentals of Aviation and Space Technology, Urbana, Ill.: Institute of Aviation, University of Illinois Press t.
Poole, Gray and Lynn, Balloons Fly High, New York: McGraw Hill Book Co., Inc., 1961 p. i.
Poole, Lynn, Ballooning In the Space Age, McGraw Hill Book Co., Inc., 1958 i.
Richards, Norman, Giants In the Sky, Chicago, Childrens' Press, 1967 i. t.

Films

Man In Flight, Walt Disney

Transparencies

Masters Story of Flight 3M Company

Pictures

Teach-A-Chart, #103, Eye Gate House, Inc., Jamaica, New York

SOARING WITH THE EAGLES

Topic

Gliders

Background

A glider is an unpowered heavier-than-air craft that stays aloft by soaring in strong currents of air. Man's first successful winged flights were made in this type of craft. A glider can be launched from a hilltop to obtain the forward thrust needed to sustain flight, or it can be towed by an airplane until the air rushing past its wings creates the lift necessary to counteract gravitational force. In strong winds, this type of craft can be launched uphill so that it is picked up by air currents flowing upward from the base of the hill. After a glider is airborne it soars into the sky and continues to fly until the wind currents can no longer sustain it.

The greatest contributions to the development of gliders were made by Otto and Gustav Lilienthal. Otto built his first glider while he was attending high school in Germany. The Lilienthal brothers observed the birds and modeled their gliders after them. They noticed that birds took off into the wind and launched their gliders the same way. They built many monoplane (single wing) and biplane (double wing) gliders and made over two thousand successful flights. Otto Lilienthal probably could have been the inventor of the airplane if a satisfactory engine had been available. He had begun development of an engine to power his aircraft, but was killed when the experimental engine failed in flight and the airplane crashed.

Octave Chanute was America's leading contributor to glider development. He invented a number of devices that are used to control the flight of the gliders.

Vocabulary

air current
air pressure
biplane
glide
glider
lift
monoplane
sailplane
soar
thrust

Suggested Activities

a. Create stories describing man's dream to fly like birds.

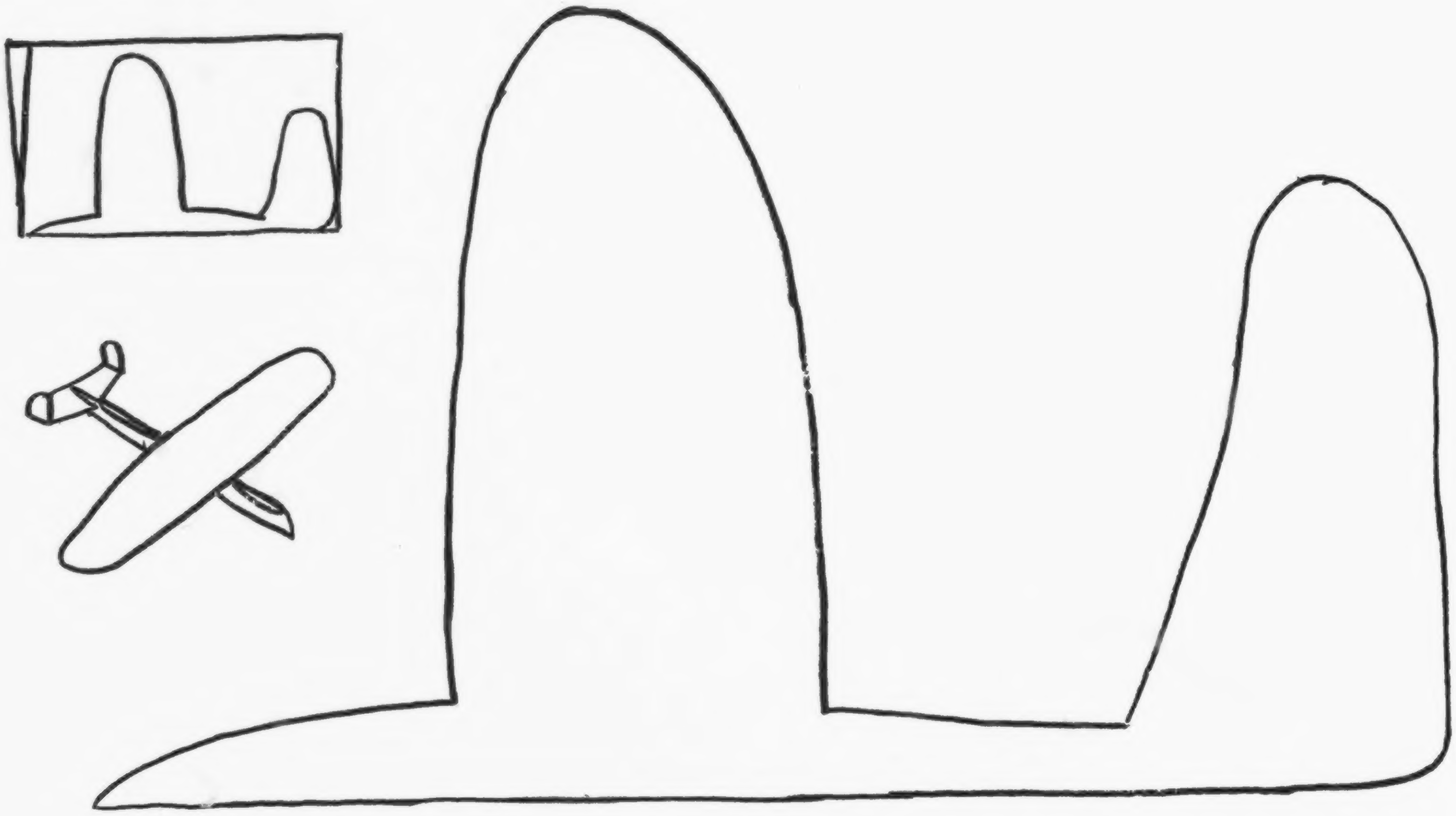
b. Have children find out about gliding as a sport.

c. Collect pictures of early gliders and sailplanes. Children could make a mural of early gliders.

d. Have a glider meet. Children could construct their own model gliders.

An opportunity for original design in wing shapes and decoration is presented by the paper glider cut from a single fold of lightweight paper. Give the class a fundamental shape to begin with, six or seven inches long, with a wing span a little greater. Cut several models, experimenting with sizes, shapes, angle of wing, types of stabilizer, weight of paper, etc., to get maximum gliding power. Good results may be obtained by fastening on the nose a small paper clip. Experiment with the amount of weight. The difference between a large paper clip and a small one may be the difference between good and bad performance in a small glider.

Cut these gliders from plain or colored paper, and encourage the children to decorate them to resemble planes, insects, or birds.



Source Materials

Books

American Heritage History of Flight, New York: Simon & Schuster, Inc., 1962
Bishop, R. W., From Kite to Kitty Hawk, New York: Thomas Y. Crowell, 1958 i.
Fisher, James, Wonderful World of the Air, New York: Garden City Books, 1958 i.
Haines, Madge, Wright Brothers, Nashville, Tennessee: Abingdon Press, 1955 p. i.
Highland, Harold, How and Why Wonder Book of Flight, New York: Grossett and Dunlap, 1961 p. i.
Kettelkamp, Larry, Gliders, New York: William Morrow and Company, 1961 p.
Laumer, Keith, How to Design and Build Flying Models, New York: Harper and Row, Inc., 1960
Reynolds, Quentin, Wright Brothers, New York: Random House, 1950 i. t.
Shippen, Katherine, A Bridle for Pegasus, New York: Viking Press, 1964 t.

Picture

Teach-A-Chart, #103, Eye Gate House Inc., Jamaica, New York

Transparency

The Story of Flight, Science Series # 29 E 3M Company

AIRPORTS--GATEWAYS TO EVERYWHERE

Topic

Airports

Background

Airports are the nerve centers of America's large cities. On a typical day thousands of passengers are served and tons of mail and freight are shipped at a large metropolitan airport. Through their doors pass people going to cities all over the world. Airplanes depart weekly on flights to Cairo, Hong Kong, Moscow, Paris, or Cape Town and travelers arriving from all parts of the world fill the large airports lending excitement to the atmosphere of these gateways to and from everywhere.

In general, the plan of any airport will include three parts. These are:

1. Services for the passengers
2. Services for the airplanes while at the airport
3. Services for airplanes while they are in flight.

An airport has several main sections:

1. Parking lot for automobiles
2. Terminal building through which passengers leave and arrive
3. The control tower from which men direct the safe movement of airplanes in and out of the airport
4. The airfield which has several parts including the ramp, runways, taxiways, and lighting system
5. Instrument landing systems which help airplanes to land safely in bad weather
6. Hangars where mechanics service airplanes
7. Equipment repair shops
8. Air freight terminals which handle the cargo shipped by air
9. Private airport hangars
10. Air Route Traffic Control Center (found in large airports) which controls air traffic flying in bad weather.

Vocabulary

control tower
hangar
ramp

runway
taxiway
terminal

weather bureau

Suggested Activities

a. Gather photographs and drawings to show how the airport of the future will differ from today's airports.

b. Construct a model airport. The buildings could be made from cardboard boxes and paper, the runways, sidewalks and roads from white cardboard strips, and the ground coated with sawdust dyed green.

c. Plan a trip to the local airport to see its facilities. Try to obtain some information for use in building a model airport to scale.

d. Have children find out about leading airports. Discuss the architectural design of various terminals. Encourage discussion and let children design a terminal.

e. Plan a classroom layout to represent the airport. Include space for a reservations desk, insurance booth, baggage check, etc. Have the children sell tickets and insurance, weigh baggage, give weather conditions, etc.

f. Have the children draw a map of an airport to scale.

g. A free story on Air Traffic Control may be obtained from:
Federal Aviation Agency Distribution Section, H. Q. 438,
Washington, D. C. 20553

h. Arithmetic problems for grades one to six may be obtained from:
National Aerospace Education Council, 616 Shoreham Building,
806 15th Street, N. W., Washington, D. C. 20005
Request the following: Aerospace Arithmetic, A Supplement for Elementary Arithmetic, Grades 1-6, price 25 cents.

Source Materials

Books

Colonius, Lillian, At the Airport, Los Angeles: Melmont Publishers Inc., 1954 p.
Schneider, Leo, Wings in Your Future, New York: Harcourt, Brace and World, Inc., 1955
Stuart, Merrie, The Airplane at the Airport, Los Angeles: Melmont Publishers Inc., 1958 p.

Films

Song of the Clouds, 35 min., Dept. of Aeronautics or Shell Oil Company
Airport in the Jet Age, 11 min., b/w, Encyclopaedia Britannica
The Best Investment We Ever Made (FA-304), 23 min., color, NASA, 1964
The Busy Airport, 11 min., color, Coronet p.
Flight, 28 min., color, Federal Aviation Agency

Filmstrips

Airport America, Dept. of Aeronautics, Lincoln, Nebraska
The Airport and Your Community, 34 frames, United Air Lines

SAFETY IN THE SKIES

Topic

Rules and regulations for safety in the air

Background

In the early days of aviation when there were only a few thousand pilots and a few hundred airplanes there were practically no regulations governing safety. In 1926 Congress enacted legislation which was designed to promote safety and to prevent needless and tragic accidents.

Today, civil aviation is controlled by two governmental bodies: the Federal Aviation Agency (FAA) and the Civil Aeronautics Board (CAB). The CAB is primarily concerned with the economic regulation of organizations engaged in public air transportation and accidents involving their aircraft. It is responsible for establishing rights to certain air routes, and setting rates for carrying of mail, passengers and goods. The function of the FAA is to regulate and promote civil aviation and military aircraft. The FAA sets standards for pilot certification and for maintaining the airworthiness of aircraft. This agency also employs several hundred highly trained aircraft controllers plus a contingent of skilled radio and radar maintenance technicians to keep the equipment in top working order.

The FAA issues pilot licenses for private pilots, commercial pilots, or flight instructors. In addition to his certificate, each pilot has a "rating" which indicates that he has specific qualifications. These include instrument flying, multi-engine craft, helicopter, etc. To become a private pilot, one must be seventeen years old, pass a medical examination, have approximately forty hours of supervised flying with an approved instructor, pass a written examination, and demonstrate a basic flying proficiency.

The FAA has also specified restrictions for flying in bad weather. As a further effort to establish safety in the skies, the FAA enforces laws concerning such things as assigned altitudes, times when radio contact must be maintained with airports, the operation of "approved" airports, aircraft passing, yielding right-of-way, use of lights, and other factors which affect aviation safety.

Vocabulary

aeronautics
altitude
ceiling
certificates
control tower
control zone
flight plan
obstacle
pattern
regulations
traffic
victor airways

Suggested Activities

a. Correlate this lesson with lessons on other types of safety. Discuss the need for rules to help insure safety.

b. Make a flight plan for an imaginary trip. Discuss the reasons for filing a flight plan.

c. Find information about and make reports on the two major governing bodies of aviation: The Federal Aviation Agency and the Civil Aeronautics Board.

d. Have children find out about requirements for obtaining a driver's license and a pilot's license. Compare them.

e. Construct a papier-mache map of a state. Draw lines showing where air highways cross the state. Indicate control zones and areas. Studying an aeronautical chart will give this information.

f. You may obtain a pamphlet on flying if you write to Jeppesen & Co., 8025 East 40th Avenue, Denver, Colorado 80207.

g. Have a representative from Civil Air Patrol talk to the students.

Source Materials

Books

Bendick, Jeanne, The First Book of Airplanes, New York: Franklin Watts, Inc., 1959 p.
Bernardo, James, Aviation in the Modern World, New York: Dutton and Co., 1960. t.
Elting, Mary, Aircraft at Work, New York: Harvey House, 1964.
Nebraska Aeronautical Chart, Lincoln, Nebraska: Department of Aeronautics, State House, $1.50 t.
Schneider, Leo and Ames, Maurice, Wings in Your Future, New York: Harcourt, Brace and World, Inc., 1955 i. t.

Films

Ground Controlled Approach of Aircraft: Operational Procedure, 38 min., b/w U. S. Office of Education, Washington, D. C.

SPEEDY LETTERS

Topic

Airmail

Background

Airmail and air parcel post are the fastest ways to send letters and packages. Early balloonists and airplane pilots sometimes carried airmail as a promotional stunt. The first official airmail service was flown by Paul Beck and Earle Ovington in 1911. On May 15, 1918, United States Army pilots began the first regular airmail service, flying between New York City, Philadelphia, and Washington, D. C. The Post Office Department took over this service in August, 1918. Private airlines carried the mail from 1925 until 1934, when this responsibility was returned to the United States Army. Congress then passed the Airmail Act which provided for government airmail contracts with private airlines and established regular airmail service.

Vocabulary

air express
airmail
air parcel post
surface mail
transcontinental

Suggested Activities

a. Design airmail stamps commemorating famous persons or events.

b. Have children obtain pen pals in other countries. One source for obtaining pen pals is:
People to People
International Headquarters
2401 Grand
Kansas City, Missouri

c. Study and report on the history of airmail. What does the future hold for airmail? A set of bulletin board pictures on the History of Mail may be obtained free by writing on school stationery to:
United Air Lines
Publicity Department
33 North Dearborn Street
Chicago, Illinois 60602

Source Materials

Books

Adams, Samuel H. *The Pony Express*, New York: Random House, 1953 i.

Arnold, Oren, *Marvels of the United States Mail*, New York: Abelard-Schuman, Ltd., 1964 p. i.
Barr, Jene, *Mr. Zip and the United States Mail*, Chicago: Albert Whitman Co., 1964 p.
McCall, Edith, Frontiers of America: *Mail Riders*, Chicago: Children's Press, 1961 p. i.
Miner, Irene Sevrey, *True Book of Our Post Office and Its Helpers*, Chicago: Children's Press, 1961 p.
Schloat, Warren, Jr., *Adventures of a Letter*, New York: Charles Scribner's Sons, 1949 p. i.

Film

Our Post Office, 11 min., color Encyclopaedia Britannica p. i.

FLYING FARMERS

Topic

The use of aviation in agriculture

Background

Modern farmers use planes to help them in many ways. On large farms seeds are sometimes planted from the air. Planes can be used to spray crops to control disease or insects. In addition to crop dusting and seeding, planes are used for fertilization, feeding and inspecting cattle hunting predatory animals, checking fences, inspecting water tanks and shipping livestock.

Helicopters are sometimes used to pollinate orchards. Fruit and vegetable crops threatened by frost can often be saved by a helicopter flying slowly overhead. Its rotors' downward thrust forces a blanket of warmer air down into the layer of cold air at ground level, thus raising the ground temperature above the freezing point.

Aviation has become so important to agriculture that in 1945, a group called the Flying Farmers was organized.

Vocabulary

crop dusting
fertilization
helicopter
insecticides
pollination
seeding
spray plane
surveying

Suggested Activities

a. Invite a Flying Farmer to talk to the class.

b. Read stories about the airplane and helicopter and how they are used on the farm and ranch; develop charts and stories about their use.

c. Collect pictures of planes which are used in various kinds of agriculture.

d. Learn how insecticides are applied from the air.

e. Investigate the use of agricultural aviation in your community and state.

Source Materials

Books

Carson, Rachel, *Silent Spring*, Greenwich, Conn.: Fawcett Publications 1962 t.

Elting, Mary, *Aircraft at Work*, New York: Harvey House, Inc., 1964 t.

Floherty, John J., *Whirling Wings*, New York: J. B. Lippincott Co., 1961 i.

Howard, Robert, *The Real Book About Farms*, Garden City, New York: Garden City Books, 1952

Hyde, Margaret O., *Flight Today and Tomorrow*, New York: McGraw-Hill Book Co., 1962 t.

Magazines

Farm Journal
Flying Farmer
Prairie Farmer

Films

The Air Age, Film Original, Idaho p.

EASY COME, EASY GO

Topic

Commerical airlines

Background

Commerical air transportation in the United States got its start in 1926 when the government awarded its first airmail contracts to private companies. During the first year the airlines carried about 250,000 pounds of mail and a few brave passengers. A mere forty years later, in 1966, United States airlines flew eighty billion passenger miles. One hundred ten million passengers were carried that year.

Every airliner has a crew whose members have been specially trained to do a particular job. The crew includes: the pilot, copilot, flight engineer, navigator, and at least one steward or stewardess.

The ocean of air has become a broad highway for the traffic of all nations. In its flight through the skies no commercial aircraft is ever alone. It is surrounded by a network of communication and navigation aids, flight information and traffic control centers.

Vocabulary

copilot
flight engineer
ground crew
maintenance
mechanic
navigator
pilot
stewardess

Suggested Activities

a. Take a field trip to a local airport.

b. Use airline timetables to suggest problems for arithmetic lessons.

c. Plan an imaginary trip on an airplane and have the children act out the duties of all the various workers involved.

d. Have the children figure the cost of traveling by air and compare it to the cost of other modes of transportation. Have them consider such factors as the savings in time, having meals served on board, etc.

e. The children might arrange classroom furniture to resemble an airliner and dramatize a flight.

f. Have the children plan a menu for an in-flight meal.

g. Make mobiles featuring items associated with aviation such as airplanes, a captain's cap, baggage, control tower, etc.

h. Find pictures of planes in use by various airlines. Make copies of the insignia used by different airlines. Children could pretend they have their own airline. They could design their own insignia and make up a name for their airline.

i. Dress dolls in typical airline costumes. Dolls and costumes could be cut from paper and colored.

j. Pupils could act as "recruiters", explaining the preparation, job expectancies, and advantages of various careers in aviation, such as airline stewardess, pilot, navigator, airport manager, engineer, etc.

Source Material

Books

Chace, Haile, About the Pilot of a Plane, Los Angeles: Melmont Publishers, Inc., 1959 p. i.
Coombs, Charles, Aerospace Pilot, New York: Morrow & Co.. 1964 i.
Floherty and McGrady, Whirling Wings, New York and Philadelphia: Lippincott Co., 1961 i. t.
Greene, Carla, I Want to be an Airplane Hostess, Chicago: Children's Press, 1960 p. (PSAB)
Greene, Carla, I Want to be a Pilot, Chicago: Children's Press, 1957 p.m (PSAB)
Greene, Carla, I Want to be a Space Pilot, Chicago: Children's Press, 1961 p. (PSAB)

Films

Airport in the Jet Age, 11 min., b/w EBF, i.
An Airplane Trip by Jet, 11 min., color, EBF p. i.
Song of the Clouds, 30 min., Shell Oil Co., Available in Nebraska at State Department of Aeronautics, Lincoln, Nebr.
The Busy Airport, 11 min., color, Coronet p.

Resource People in your Community (Suggested List)

Flight engineer
Airplane mechanic
Flight control personnel
Patron of a jet airline
Pilot
Stewardess
Weatherman

Related Field Trips: Air National Guard; airport (field, terminal, tower); heliport; observatory; planetarium; Post Office; telephone company.

CARGO CARRIERS

Topic

Air cargo

Background

Two groups conduct the air cargo business: (1) the all-cargo airlines, and (2) the regular domestic and international airlines. The all-cargo airlines were established to carry air cargo exclusively.

The use of airplanes as commercial cargo carriers has increased steadily since the end of World War II. The volume hauled by United States carriers has grown from a little more than fifty million cargo-ton-miles in a year to nearly one billion cargo-ton-miles. (One cargo-ton-mile means a ton of cargo transported one mile.)

All kinds of cargo are carried, including such commodities as perishable fruits and vegetables, automobile parts, medicines, textiles, cutlery, optical goods, jewelry, as well as race horses, monkeys, tropical fish, and elephants for zoos.

Vocabulary

air cargo
air freight
all-cargo
cargo

commerce
commodities
export
import

international
perishable
trade
transport
volume

Suggested Activities

a. Make a bulletin board showing items transported by air. Label the country or state from which the product came.

b. Have the children write creative stories about animals riding in airplanes. The shipment of elephants, for instance, might be used for such a story. The airlines found that elephants are more tranquil when chickens are shipped with them, so chickens have been trained to sit on the heads of elephants during flights. Material such as this would make a very whimsical story.

c. Have the children bring to class items made or produced in other countries. Place them in a display area with a large map of the world above them. Using yarn, attach the item to a point on the map where the product came from. Indicate which items probably were transported by air.

d. By use of graphs, compare the cost of freight hauled by plane, train or truck and chart the time saved by use of air travel.

Source Materials

Books

Bendick, Jeanne, The First Book of Airplanes, New York: Watts, 1958 i.
Bernardo, James V., Aviation in the Modern World, New York: E. P. Dutton & Co., 1960 t.
Cooke, D. C. Transport Planes That Made History, New York: Putnam, 1959 i.
Elting, Mary, Aircraft at Work, New York: Harvey House, 1964 i.
Puccinelli, Marie, Jungle in the Sky, New York: Putnam, 1963 t.

PRODUCTS FOR PROGRESS

Topic

Industry in the air age

Background

Our economy has expanded greatly because of the effect that aviation and space technology has had on business and industry. America has been known as a nation on wheels, however, it is rapidly becoming a nation on wings.

The aerospace industry is one of the largest businesses in the United States. It employs thousands of people in all kinds of work. Aerospace workers include electronics engineers, aeronautical and mechanical engineers, meterologists, cargo handlers, market reseachers and analysists. In addition to the men who plan and design airplanes and spacecraft, there are more than 650,000 working in the factories building the hardware.

The research and development connected with aviation and space technology also is an important source of employment for many people. Inventing, designing and building the new equipment associated with the space effort is making jobs for thousands of people in many fields.

Aerospace work includes job opportunities for technical, nontechnical, professional and non-professional workers. Scientists and engineers are required to design and plan the equipment, but almost fifty per cent of the industry's workers are tool and die makers, sheet metal workers, machine tool operators, welders, inspectors, assembly line production workers and maintenance workers.

In recent years over fifty per cent of the federal government's budget has been allocated to national defense. Much of this money has been channeled into the aerospace manufacturing industry for research development, and production work on airplanes and jets, missiles and spacecraft.

It is evident that aviation is big business and is vital to the economy of our country.

Vocabulary

designers
economy
engineers
factories
industry
innovation
maintenance
manufacturer
production
research
semi-skilled workers
skilled workers
technicians

Suggested Activities

a. Have the children try to find out how many people in their own community are engaged in working with or for an industry or service connected with aviation.

b. List cities in the United States whose economy is largely dependent on aerospace industries. Find out how some areas--Cape Kennedy, for example--have developed and grown primarily because of this new industry.

c. Have children write reports on some of the varied occupations connected with aerospace industry.

d. Role playing could be employed to portray various workers.

e. Make a bulletin board on "Aerospace Workers in Our Community."

f. Interview workers from other businesses and industries to see how the aerospace industry affects them.

Source Materials

Books

Bernardo, James V. Aviation in the Modern World, New York: E. P. Dutton and Co., 1962 t.
Binder, Otto O. Careers in Space, New York: Walker and Co., 1964 t.
Elting, Mary, Aircraft at Work, New York: Harvey House, 1964 i.
Floherty, J. J. Aviation From the Ground Up, Philadelphia: Lippincott 1959 t.
Foundations of Air Power, Washington GPO, 1959, Cat. No. #301 63 Ai7 t.
Lent, Henry B. The Helicopter Book, New York: Macmillan Co., 1956 i.

Chart

A free air transportation chart (12 x 17) depicting the major types of jobs held by airlines and other air transportation workers may be obtained from:
United States Department of Labor
Bureau of Labor Statistics
Occupational Outlook Service
Washington 25, D. C.

Film

Air Age, 30 min., Dept. of Aeronautics, General Aviation Bldg., Municipal Airport, Lincoln, Nebraska

Pamphlet

A free booklet on aerospace industry may be obtained from:
Aerospace Industries Association
1725 De Sales St. N. W.
Washington 25, D. C.

GOGGLES, BOOTS, AND JENNIES

Topic

Barnstorming

Background

More than forty years ago some daring young men and women performed spectacular feats in the sky. They were known as birdmen, sky pilots, boomers, barnstormers, and lunatics. However, the name barnstormer was more generally accepted. The name came from the fact that they used barns as hangars. Their landing fields were pastures. They had crude instruments, unreliable maps, no navigational aids, no weather stations, and they had to make their own repairs. The planes generally were Jennies and Standards powered by a Curtiss OX-5 or Hissos of 150, 180, or 220 horsepower. The barnstormers thrilled thousands of spectators with loops, spins, stalls, tailslides, fat barrel rolls, and chandelles. There were breakaways where the stuntman would change planes, then skid, and begin to hang from the wing with his knees--then a hand--then a knee; acrobatics where the stuntman would grab onto a rope hanging from the landing gear and proceed to climb into the cockpit; and numerous other thrilling performances. It must be remembered that some of these daring wing-walkers were women as well as men.

Gypsy barnstormers were loners who were only interested in making money. Professional barnstormers gained personal fame by performing in air circuses. Both types visited the county fairs to take passengers up in the sky. The usual price for a ride was five dollars per person.

There were no federal pilot licenses required before mid-1926; hence, there were no records kept on the actual number of pilots who worked as barnstormers. Some of the more famous barnstormers were Charles Lindbergh, Frank Hawks, Major Bill Long, Captain Bobbie Jewell, Margo Jewell, Glenn H. Curtiss, and Ruth Law.

Federal regulations and changing times led to a different kind of air entertainment. The air shows of today do a big business at airport dedications, fairs, and racing meets. People are thrilled to see sky divers perform, and the biggest air show of all is a performance by the Thunderbirds or the Blue Angels.

Vocabulary

barnstorming
Blue Angels
chandelles
hangars
instruments
navigation
regulations
skydiving
spin
stall
Thunderbirds

Suggested Activities

a. Discuss the reasons for air shows being so popular. The children can tell about air shows they have seen.

b. Have children find out about the early days of barnstorming. They might locate old newspapers, talk to people who watched the barnstorming feats, or rode with the barnstormers, and write letters to some of the old barnstormers. There are excellent articles and books available on the subject.

c. Write biographies of the early barnstormers.

d. Compare the old air circus with the present sky shows.

e. Arrange displays of the old biplanes and modern planes.

f. Have the children draw their impressions of an early air circus.

g. Consider the overall flying conditions of the 1920's as compared with those of today.

Source Materials

Books

American Heritage History of Flight, New York: Simon and Schuster, 1962 i. t.
Caidin, Martin, Barnstorming, New York: Duell, Sloan, and Pearce, 1965 t.

PIONEERS OF THE AIR

PIONEERS OF THE AIR

OVERVIEW

A few of the great contributors in the field of aviation and aerospace are presented in the section, "Pioneers of the Air." These "greats" benefited as individuals, but the greatest recipient was the society in which these contributors lived.

One of the significant contributions classroom teachers can make is to introduce children to the lives of men and women worthy of emulation. The material included in this section presents information about a few of the pioneers in the development of flight.

LIGHTER THAN AIR

Topic

Joseph Michel and Jacques Etienne Montgolfier

Background

The earliest accounts of how the Montgolfier Brothers discovered the way to make a balloon float, vary considerably. We do know that they experimented with smoke and found that heated air could exert a strong upward pressure. In the early summer of 1783, they made a paper-lined, linen bag which had a circumference of more than one hundred feet. On June 4, the balloon was taken to the village square, where a crowd had gathered. A fire was built under the balloon and it began to inflate. Eight men were required to hold it down to the earth. When they released it, it soared to an altitude of 6,000 feet before it landed more than a mile away.

After this successful experiment, the King of France asked the Montgolfiers to bring their balloon to Paris. On September 19, 1783, the great balloon was taken to the Garden of Versailles. Etienne had wanted a man to stand in the basket and float into the sky, but King Louis XVI refused. The king compromised, however, and allowed a chicken, a duck, and a sheep to be placed in the basket. They were the first living creatures to be lifted into the ocean of air. The balloon came down after a flight of about an hour.

Since the purpose of the Montgolfier balloons was to get men into the air, the brothers were not satisfied until this could be accomplished. The King offered to send a criminal on a test flight, but de Rozier (curator of the Royal Museum of Natural History) felt this was an honor which should not be bestowed upon a common criminal. Pilatre de Rozier and Marquis d'Arlandes were finally allowed to ascend into the air. They stayed aloft for over four minutes and reached a height of almost eighty-five feet.

Suggested Activities

a. Compare the early accounts of the Montgolfier Brothers balloon experiments to see how they differ.

b. To demonstrate the fact that hot air rises observe the waves of air which rise above a hot radiator.

   Place a lighted candle in front of a window. Turn off the room lights and observe the waves of heated air rising above the candle.

c. To demonstrate the way in which a balloon filled with lighter-than-air gas floats upward fill a glass with water and push a piece of cork down to the bottom. As the cork is released it rises to the top of the water and floats because it is lighter than water. (For additional activities see page 52)

Source Materials

Books

American Heritage History of Flight, New York: Simon and Schuster, Inc., 1962 t

Burchard, Peter. Balloons from Paper Bags to Sky Hooks, New York: The Macmillan Co., 1960 i

Highland, Harold Joseph, The How and Why Wonder Book of Flight, New York: Grosset and Dunlap, 1961 i. t.

Poole, Lynn and Gray, Balloons Fly High, New York: McGraw-Hill Book Company, Inc., 1961 i

Richards, Norman, Giants in the Sky, Chicago: Children's Press, 1967 i. t.

Shippen, Katherine B., A Bridle for Pegasus, New York: Viking Press, 1964 i. t.

Pictures

History of Flight Series, Teach-A-Chart #103, Eye Gate House Inc., Jamaica 35, New York

FREE AS A BIRD

Topic

Otto Lilienthal

Background

Otto Lilienthal, one of the pioneers of flight, was born in Germany in 1848, and died in 1896. As a child, Otto was obsessed with the idea of flight. While he was still in high school Otto built his first glider. Its wings measured six feet by three feet. Otto recorded his observations of birds flying directly into the wind, and used this information in his own flights. His early gliders were monoplanes with cambered wings and fixed tails. The pilot dangled like a marionette beneath the craft. The only means of controlling the glider was the shifting of weight. By swinging his hips and legs forward or backward, or from side to side the pilot could alter the glider's path. In 1891, Otto made the first successful glider flight.

By 1896, Lilienthal was ready to attempt powered flight. He had constructed a glider with flapping wing tips. For power, he had built a small motor that operated on compressed carbonic acid gas. On August 9, 1896, he was making a routine glide, when a gust of wind stalled the glider, and it crashed to the earth. Lilienthal's back was broken, and he died the next day.

Suggested Activities

a. Construct gliders using balsa sticks.
(For additional activities see page 52)

Source Materials

Books

American Heritage History of Flight, New York: Simon and Schuster, 1962 i. t.
Highland, Harold Joseph, *The How and Why Wonder Book of Flight*, New York: Grosset and Dunlap, 1961 i.
Shippen, Katherine, *A Bridle for Pegasus*, New York: The Viking Press, 1964 i. t.

Chart

Lilienthal, Otto, Teach-A-Chart, Eye Gate House Inc., #103

Transparency

Parts of an Airplane (three overlays) #811-1 Instructo

Toy Gliders

THE SOARING BIRDMEN

Topic

Wilbur and Orville Wright

Background

The poem, "Wilbur Wright and Orville Wright" by Rosemary and Steven Benet (poetry section) is an excellent summation of the highlights of the life of the Wright brothers. Wilbur, who was four years older than Orville, was more scientific than his brother, but Orville was the enthusiast. Orville was always ready to attempt untried things.

Bishop and Mrs. Wright were friends and advisors to the boys. Bishop Wright aroused their curiosity and challenged their thinking. He often gave such advice as, "Don't give up because something is hard to do," or "Don't try to do a thing until you are ready to do it properly in every detail."

The following time line indicates highlights in the lives of the Wright brothers.

1867 - Wilbur Wright was born in Henry County, Indiana.

1871 - Orville Wright was born in Dayton, Ohio.

1878 - The Wright family moved to Cedar Rapids, Iowa. Bishop Milton Wright brought home a toy which flew. Orville and Wilbur's intense interest led them to study its performance. A few years later, the knowledge gained from this toy was put to use in practical aeronautics.

1889 - Orville and a friend became interested in the printing business. With the help and encouragement from Bishop Wright they started printing a paper entitled "The Midget." Later Orville made a larger printing press. Wilbur joined Orville and his friend in the printing business. Orville dropped out of school. Other printing ventures resulted in "West Side News" and "Snapshots."

1893 - Interest turned to the sport of bicycle riding and racing. Wilbur and Orville opened a small bicycle shop known as the Wright Cycle Company.

1899 - Following much study and experimentation, the Wrights concluded that the Chanute type of biplane, with slightly curved surfaces, was the one they would attempt to build. They discovered a method of warping wings, a distinctive feature of every Wright airplane.

1900 - Their first glider was completed and tested at Kitty Hawk. They proved to themselves that their elevator and wing-warping principles were correct.

1901 - At Kitty Hawk, the Wright brothers proved that a front rudder scheme helped in landing safely.

1902 - Wilbur and Orville made a wind tunnel and devised their own air pressure tables. They knew what curvature to build into the wings. Their new glider made a thousand flights. It flew at 36 m. p. h. and stayed in the air for a half-minute at a time.

1903 - A motor and propeller had been added to the glider. They now had a plane rather than a glider. On December 17, with five men watching, they flew the plane 120 feet. It stayed in the air 12 seconds.

1904 - The British government sent a representative to Dayton to talk to the Wright brothers, but the Wrights refused to sell to a foreign government.

1905 - On October 3, Wilbur flew 24 miles at an average speed of 38 m. p. h.

1909 - The Wrights sold their patents to Italy for $200,000. An English sportsman paid $25,000 for a plane. Germany became interested. The United States offered $25,000 for a machine that could carry two men ten miles at 40 m. p. h. and $2,500 more for every mile of greater speed. The government paid $30,000 to the Wrights for these improvements.

1910 - A Wright plane broke the altitude record.

1911 - The Wright brothers were administrators of one of the largest airplane factories of the world.

1912 - Wilbur Wright died.

1913 - The British Wright Company was organized.

1914 - Orville announced completion of the automatic stabilizer.

1917 - Military interests became the dominating factor in the growth of aviation. Orville became Major Wright. Orville and Wilbur's father died.

1918 - Orville built a special laboratory in Dayton and continued to carry out his experiments. He refused the Smithsonian Institute their request for the plane flown on December 17, 1903.

1920 - On July 17, a monument to Wilbur's memory was dedicated in France.

1928 - Orville shipped his first airplane to a museum in South Kensington, England. He continued to seek still greater advances in the science of flying. He was a man to whom monuments meant little, but accomplishments meant much.

1945 - Orville Wright died.

Suggested Activities

a. Cut cardboard in various shapes and sizes. Put various folds and cuts into the pieces. Have children experiment by letting these pieces flutter through the air. The children should observe the variations in their performance due to the differences in shape.

b. Observe the anniversary of powered flight on December 17 by making posters for display in the school corridors.

c. Have a committee work with the librarian to prepare a display of books about the Wright brothers.

d. Be a newspaper reporter and write an account of the first successful airplane flight. (For additional activities see page 52.)

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Charts

Wright Brothers, First Powered Flight, Chart 5 - Teach-A-Chart #103, Eye Gate House, Inc., Jamaica, New York

Pictures

Wright Brothers Portfolio, a selection of 10 black and white pictures (8" x 10") on the lives and work of the Wright Brothers, $1.00 National Aerospace Education Council, 616 Shoreham Building, 806 15th St. N. W., Washington, D. C. 20005

Films

First Flight of the Wright Brothers, McGraw- Hill Text Films. i.
From Kitty Hawk to Orbit, 30 min., b/w, Douglas Air Craft Company
Man in Flight, Walt Disney p. i.

Filmstrip

Wright Brothers, 1 filmstrip, color, Famous America Series, Jam Handy i.

Leaflets

The Wright Brothers, No. 8 (rev.) Free. Supt. of Documents, United States Government Printing Office, Washington, D. C. 20402

Wright Brothers Day, National Aerospace Education Council, 616 Shoreham Building, 806 15th St., N. W., Washington, D. C. 20005

Wright Brothers National Memorial, Dept. of Interior, Leaflet No. I 29. 21:W93/965. 10¢ Supt. of Documents, United States Government Printing Office, Washington, D. C. 20402

Record

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THE LONE EAGLE OF THE PLAINS

Topic

Charles A. Lindbergh

Background

One of the most important steps in aviation history was the non-stop flight of Charles A. Lindbergh between the United States and Paris. Lindbergh received his early flight training in Lincoln, Nebraska.

Everyone in Lincoln was excited about Lindbergh's flight to Paris. Strangers on the street were pointing to the headlines of the paper and saying, "Great, isn't it?" The Lincoln Chamber of Commerce sent this cable to Lindbergh: "Congratulations, Lincoln is very proud of your achievement." On May 22, 1927, the Lincoln Sunday Star reported:

> The small flying colony in Lincoln was excited. Most had known him as "Swede," a daredevil of a youngster learning how to fly out on the old field at Twentieth Street near the Country Club.
>
> "We're certainly glad to know that Charlie made it said Johnny Moore, 148 South 27th who owns Arrow Aircraft Company in Havelock. "We remembered him as a daring and ambitious flyer, and when we heard he was going to attempt to fly across the Atlantic we were not exactly surprised. Now that he has done it, we are happy as we can be."
>
> In the fall of 1925, Charles Lindbergh came back to Lincoln, an expert flier of the air mail service....Three years after having taken a course in instruction under Roy Pages' instructors.
>
> In 1925, Lindbergh was flying a Lincoln Standard Aviation plane - the company owned by Page - and he had obtained a leave of absence from the mail service. He was doing commercial aviation work and stopped off at Lincoln for ten days while his plane was being overhauled at Johnny Moore's shop in Havelock.
>
> Lindbergh's instructors in Lincoln were I. O. Biffle, E. D. Barnes, and Aaron Ball, in the order named. Biffle had the youngster first, and the other two aided him through the final phases of his basic training.
>
> Biffle, who is an air mail flier now on a route from Omaha to Chicago, remembers Lindbergh as a "nervy youngster The "Swede" was hunting for thrills.
>
> One day he asked a flier which would be the greater thrill, to make a parachute jump from a balloon or from an airplane. The flier thought an airplane jump would carry more "kick."

"Well, then," asked Lindbergh, "which would be the bigger thrill, to use one parachute or two?"

"A double parachute would give you the bigger thrill," Lindbergh was told, "because you never can tell when the second bag is going to open."

Accordingly, Lindbergh took a double parachute jump four days after he arrived in Lincoln to learn the flying game.

Lindbergh has jumped four times and never has been injured. Once his plane crashed in mid-air, and he parachuted down to safety. That was in San Antonio, where he took a pursuit course in the army service. Not long afterwards when he was flying out of St. Louis, he took a new plane aloft to test it out. When he put the ship into a tail spin, the severest test of all, she crumpled under the strain and the "Swede" jumped for his life.

But the best local story they tell about Lindbergh is one of his vain attempts to find a flier who would let him try a particular stunt. He had an old motorcycle which he used to go along with while he was on the ground, and his plan was to ride the machine under a low-flying plane and swing up to the ship.

Lindbergh tried all over town to get a flier who would consent to the stunt but he never succeeded.

Captain Charles A. Lindbergh, United States Air Mail pilot, left Roosevelt Field, Long Island, New York, at 7:52 A.M. alone in a monoplane, The Spirit of St. Louis. He was competing for Raymond Orteig's reward of $25,000 offered for the first New York to Paris non-stop flight. He reached Le Bourget Air Field, Paris, 5:21 P.M. (10:21 P.M. Paris time) on May 21, after completing three thousand six hundred ten miles in thirty-three hours, twenty-nine minutes and thirty seconds. Lindbergh returned to the United States on the cruiser, Memphis, United States Navy, with his plane. He was welcomed by President Coolidge in Washington on June 11. New York welcomed Lindbergh with a "ticker-tape" demonstration on June 13.

The following time line indicates highlights in the life of Charles Lindbergh.

1902 - Born February 4, Detroit, Michigan. Raised in Little Falls, Minnesota.

1920- Studied mechanical engineering at University of Wisconsin.

1922 - Learned to fly at Lincoln, Nebraska with Lincoln Aircraft Corporation.

1924 - Enrolled as a flying cadet in United States Air Service Reserve at Brooks Field, Texas.

1926 - April 15, first flight as an air-mail pilot for Army Air Mail Service from Chicago to St. Louis.

1927 - May 10, flew plane from San Diego to St. Louis. Two days later he flew to New York in 21 hours 45 minutes to set a record for transcontinental flight. On May 20-21, he flew from Roosevelt Field, New York to Le Bourget airport near Paris -- 3,610 miles in 33½ hours. Awarded Congressional Medal of Honor.

Visited Mexico, Central America, and the Orient as an ambassador of good will.

1929 - Married Anne Spencer Morrow.

1930 - Mr. and Mrs. Lindbergh made a 30,000 mile transatlantic flight to explore possible air routes.

1935 - Lindberghs moved to England and later to France.

1939 - Returned to serve with United States Air Corps and National Advisory Committee for Aeronautics. Became a spokesman for neutrality for the United States in World War II.

1941 - Became a civilian advisor to manufacturers of military aircraft.

1944 - Went to the Pacific to study operation of P-38 twin engine planes in combat and flew 50 missions. Extended range of P-38 by five hundred miles.

1949 - Won Wright medal for contributions to aeronautics.

1954 - Became a brigadier general in Air Force Reserve. President Eisenhower named him to a special committee selecting a site for the Air Force Academy.

Spirit of St. Louis awarded 1954 Pulitzer Prize for biography.

1957 - Became a technical advisor to Pan American World Airways.

Suggested Activities

a. Compare the type of reporting which appeared in the 1927 newspaper article with a similar article which might appear today.

b. Draw pictures of Lindbergh crossing the Atlantic in his plane, his landing in Paris, and his reception in New York.

c. Have children write to Lindbergh in care of publisher. Charles Scribners Sons, 597 Fifth Avenue, New York City, N.Y.

d. Call your local flight operator to determine the names of individuals in your community who remember the days when Lindbergh was flying. Invite them to visit your class. (For additional activities see page 52)

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Books

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Lindbergh, Charles A., *We*, New York: Charles Scribner's Sons, 1927 t

Cooke, David C., *Flights That Made History*, New York: G. P. Putnam's Sons, 1961 i
Dalgliesh, Alice, *Ride on the Wind*, New York: Charles Scribner's Sons, 1956 i
Davis, Kenneth Sydney, *Flight to Glory*, New York: Garden City Books, 1960
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Film

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Chart

Charles Lindbergh: First Solo Transatlantic Flight, Chart 7, Teaching chart #103, Eye Gate House, Inc., Jamaica, New York

LADYBIRDS

Topic

Women aviators

Background

Many women have made significant contributions in aviation and space flight. Some of the more noteworthy are:

1908 Baroness de la Roche
The first woman airplane pilot was the Baroness de la Roche who soloed in France in 1908. She was the first woman to receive a pilot's license.

1911 Quimbly, Harriet G.
She was the first American woman to receive a pilot's license. She was also the first woman to fly the English channel.

1912 Stinson, Marjorie and Katherine
Katherine learned to fly at age 16. Marjorie helped her brothers, Edward and Jack, set up a flying school in Texas.

1916 Law, Ruth
Ruth was one of the earliest women exhibition fliers.

1927 Elder, Ruth
Ruth attempted to fly from Roosevelt Field, Long Island, to Europe with George Haldeman, but they crashed near the Azores. She later became a movie star.

Early 30's Nickols, Ruth
Ruth was the first licensed sea-plane pilot and the second licensed woman transport pilot in the United States. She was the first national recipient of the Harmon Trophy (for women) in 1936. She then held the world's records for altitude, speed, and distance.

Earhart, Amelia
Amelia established the women's auto-gyro record in 1931. She soloed the Atlantic in a Lockheed Vega. Amelia held most of the world's records for women during the late 20's and early 30's. Twice she was selected as the outstanding woman pilot of the world. In 1937 she was lost on a round-the-world flight near the Howland Islands.

Thaden, Louise
Louise was the holder of speed and endurance records in the early 30's.

Piccard, Jeanette
Jeanette was the first woman to soar into the stratosphere in a balloon. She was the holder of a world record. Her husband, Jean, was a famous balloonist.

Omlie, Phoebe
Phoebe, the first licensed woman transport pilot in the United States, outflew men as well as other women to win the national sweepstakes race from California to Ohio. President Franklin D. Roosevelt named her as special assistant for air intelligence.

1930's Johnson, Amy
Amy soloed across Europe and Asia to Australia.

Miller, Betty
Betty flew a twin-engined Piper Apache across the Pacific from east to west. The four-stage seven thousand mile flight began in Oakland, California on April 30 and ended in Brisbane, Australia on May 12, 1933.

1955 Lindbergh, Anne Morrow
Anne is a pilot, author, and wife of Charles Lindbergh. She wrote "A Gift from the Sea" and several other books.

1960's Cochran, Jacqueline
Jacqueline is the current holder of most aviation records for women. She holds many jet records and in 1953, she became the first woman to fly faster than the speed of sound.

1960's to present Auriol, Jacqueline
Jacqueline, of France, flew a reconnaissance version of the Delta-wing, Mirage III fighter, to a new woman's air speed record over a sixty-two mile course at Istres in southern France in 1963. Her time was 1,260 miles per hour.

Mock, Jerrie
Jerrie made a round-the-world solo flight in 1964.

Smith, Joan Merriam
Joan made a round-the-world solo flight in 1964.

Tereshkova, Valentina
Valentina, the first lady cosmonaut from Russia, orbited the earth forty eight times.

Suggested Activities

a. Discuss the Powder Puff Derby which is the highlight of the year for many amateur women aviators.

b. Make airplane models. Directions and materials needed are found on pages 112-113 of Compton's Pictured Encyclopedia, Vol. I, 1962.

c. Suggested assignment: An illustrated, biographical sketch, or a booklet about women in aviation.

d. Plot the route Earhart traveled when she crossed the Atlantic alone. (For additional activities see page 52)

Source Materials

Books

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Garst, Shannon, *Amelia Earhart: Heroine of the Skies*, New York; Messner, 1962. t.
Greene, Carla, *I Want to Be An Airplane Hostess*, Chicago: Children's Press, 1960. p.
Hoyt, Mary Finch, *American Women of the Space Age*, New York: Atheneum Publishing Co., 1966. t.
May, Charles Paul, *Women in Aeronautics*, New York: Thomas Nelson and Sons, 1962. t.
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Phleger, Fred, *Ann Can Fly*, New York: Beginners Books, Inc., 1959

HEROINE OF THE SKY

Topic

Amelia Earhart

Background

Amelia Earhart, born in Kansas in 1897, had always been an adventuress. The idea of flying captivated her even while she was a small child. This fascination keep growing and as soon as she could, she took flying lessons. Because of financial problems Amelia did not devote all of her time to flying. She earned money at various jobs to pay for her lessons.

In 1928 Amelia Earhart became the first woman to cross the Atlantic Ocean in an airplane. She was a passenger aboard the "Friendship" which was piloted by Wilmer Stultz and Lou Gordon. When people praised her courage she said, "The bravest thing I did was to try to drop a bag of oranges and a note on the head of an ocean liner's captain--and I missed the whole ship!" She wrote a book about this experience and later married her publisher, George Putnam.

Amelia flew the Atlantic alone in 1932, from Harbor Grace, Newfoundland to Ireland. She was the first woman to fly from Honolulu to the mainland of the United States, and the first to fly across the United States alone in both directions. Amelia, on a goodwill flight from Mexico City to New York, was the first person to fly this route successfully.

Her last major undertaking was to fly around the world at the equator. Flights around the world had been completed before, but the pilots had used the polar route instead of the equatorial route. Her family did not want her to go, so she promised this would be her last long flight. Flying a Lockheed Electra, with Fred Noonan as navigator, they set out from Oakland, California for Honolulu. Trouble developed, however, and the plane was damaged in an emergency landing. By the time the plane was repaired, the weather was not favorable for an east-to-west flight, so Amelia changed her plans and decided to fly from the east coast and cross the Atlantic first. Amelia enjoyed her experiences in Africa, Sudan, India and arrived in New Guinea in late June, 1937. Her next scheduled stop was tiny Howland Island,two thousand five hundred fifty six miles across the South Pacific. On July 2 Miss Earhart and Fred Noonan took off. A United States Coast Guard vessel, the Itasca received radio messages from the plane that told of head winds and heavy fuel consumption. There were no further messages from the aircraft.

For sixteen days, planes and ships hunted for them but found nothing. They were assumed lost forever in the Pacific.

Amelia Earhart was a shining example of dedication and courage. In a letter she gave her husband before one of her long flights, she said, "I want to do it because I want to do it. Women must try to do things as men have tried. When they fail, that failure must be but a challenge to others."

Suggested Activities

a. Construct a mural showing the major events in Amelia's life and flying career.

b. Amelia Earhart loved to write poetry about the sky, flying, courage, etc. Have the children write poems about these subjects, then you may read some of Amelia Earhart's poems and compare the thoughts expressed in both poems.

c. Plot the course of Amelia's round-the-world flight on a globe. (For additonal activities see page 52).

Source Materials

Books

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ROCKET PIONEER

Topic

Robert Goddard

Background

Dr. Robert Goddard was the pioneer scientist and engineer who established the technical foundations for many of today's developments in long-range rockets, missiles, earth satellites and space flight. He founded a new field of science and engineering, now grown into a multi-billion dollar industry. He was born in Worcester, Massachusetts in 1892, and died in 1945.

Robert Goddard's interest in rockets began when he was seventeen years old. As early as 1908 he carried out static tests with small solid-fuel rockets at Worcester Polytechnic Institute. In 1912 he worked out the detailed mathematical theory of rocket propulsion, and showed that a rocket, because it does not need air to sustain its flight, could be sent to the moon or into space, provided an efficient motor could be developed.

In 1914 he began to experiment with larger rockets. By 1916 he had reached the limit of what he could do on his own resources. With the support of the Smithsonian Institution, Dr. Goddard was able to continue his work on solid-propellant rockets, and to begin developing liquid-propellant rockets.

When the United States entered the First World War in 1917, Dr. Goddard volunteered his services to the nation. He was assigned the task of exploring the possiblitiy of developing a military use for his rockets. He succeeded in developing several types of solid-propellant rockets intended for use against tanks or other military objectives. These missiles were to be launched from a stand, or a tube held in the hands. They were similar in many respects to the bazooka of World War II. Goddard successfully demonstrated his weapon at the Aberdeen Proving Grounds in Maryland, but the armistice was signed before the weapon was put into use.

In 1919 Dr. Goddard summarized his mathematical explorations, the results of his solid propellant research and some of his ideas about space flight in a classic paper entitled "A Method of Reaching Extreme Altitudes." The paper was published by the Smithsonian Institution, and is still considered to be one of the basic documents in rocket and jet propulsion literature. It has been the source of numerous developments that have come about since its publication. Many of Goddard's early rockets and rocket components are on exhibit in the National Air Museum, Washington, D. C., and in the museum at Rosewell, New Mexico.

During the Second World War Goddard again offered his services to the government and was asked to help develop a practical method of providing jet-assisted take-off power for airplanes. His work was successful, and he continued working on rocket propulsion until his death in 1945. Since then his notes have provided material for another book, "Rocket Development."

Robert Goddard was the first modern scientist who perceived the possiblities of rockets and space flight, and undertook the enormous work of bringing them to practical application. His contributions are recognized as being among the most important technical achievements of modern times.

Suggested Activities

a. Plan an observance of "Goddard Day." The class might write a play which dramatizes some of the disappointments and some of the satisfactions which Goddard experienced during his career. Other kinds of activities for "Goddard Day" might include original songs, poems, art exhibit, etc.

Other classes might be invited to attend the program as guests.

b. Design appropriate posters calling attention to "Goddard Day."

c. Draw a map of the United States and indicate on it the places where Robert Goddard lived and worked during his lifetime. At the bottom of the map write a brief sentence or two about the events that happened at these locations.

d. Have children prepare a report on ways in which the development of the rocket has changed the world.

e. Ask children to make a list of new words they have learned while reading about Dr. Goddard and rockets. Have them include definitions. (For additional activities see page 52.)

Source Materials

Books

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IGOR'S NIGHTMARE

Topic

Igor Ivanovich Sikorsky

Background

As a schoolboy in Kiev, Russia, Igor Sikorsky dreamed about flying. He obtained his first reliable information and pictures about the flight of the Wright brothers in 1908. This inspired him to go to Paris, France to study the planes. Returning to Kiev, he built two helicopters, neither of which was successful. Sikorsky started making small, single-engine planes. The first did not fly at all and the second crashed after a few leaps. His fifth plane, the S-5, set a world's speed record in 1911. In 1913 he built the world's first multi-engine plane which was active against the German Army in World War I.

After the Russian Revolution in 1919, Sikorsky came to the United States and formed a company of his own. Among his designs were the largest freight-carrying planes of the day, and the Clippers which were the first to carry passengers and freight across the Atlantic and Pacific Oceans.

In 1929 Sikorsky set aside his work and began designing his strange flying machine. For approximately ten years he studied, planned, and applied for patents on new helicopter designs. He tacked this sign on the wall:

> "According to all recognized aerodynamic tests, the bumble bee cannot fly, because of the shape and weight of its body in relation to its total wing area. But the bumble bee doesn't know this. So it just goes ahead and flies anyway."

This was his answer to his friends and fellow workers who kept teasing him about his strange machine. Sikorsky kept the bumble bee in mind and kept on working on his flying machine.

In the spring of 1939, he designed and assembled the VS-300. It had a four-cylinder, seventy-five horsepower, air-colled engine. Topping the welded steel frame was a three-bladed main rotor, 28 feet in diameter. The cockpit was completely open and the landing gear consisted of two modified bicycle wheels.

On September 14, 1939 the first successful flight of a direct-lift aircraft was made. Three years later, in 1942, the first army helicopter, the R4, was completed.

Sikorsky has since retired but is still planning and drawing up blueprints for the helicopters of the future.

Suggested Activities

a. On a map have children locate Igor Sikorsky's home, Kiev, Russia. What countries would he have to cross on his way to Paris? How would traveling have been different in 1908?

b. Find pictures of Leonardo da Vinci's designs for a flying machine.

c. Write stories suggested by a sentence fragment. Example: "We had been cruising in the helicopter for an hour or so when suddenly. . ." (For additional activities see page 52)

Source Materials

Books

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Films

History of the Helicopter, 2 reel, color, Encyclopedia Britannica Films

OPEN DOORS TO EXPLORATION

Topic

Wernher von Braun

Background

Wernher von Braun has shown a dedication to space travel all his life. His feelings are expressed in these words:

> "Everything in space obeys the laws of physics. If you know these laws, and obey them, space will treat you kindly. And don't tell me man doesn't belong out there. Man belongs wherever he wants to go---and he'll do plenty well when he gets there."

Wernher von Braun was born March 23, 1912, in Wirsitz, in the province of Silesia, Germany. His parents were landholding,aristocratic Prussians. He received his bachelor's degree in engineering in 1932, and got his doctorate in physics in 1934. Before this he had been most interested in space exploration and had read everything available on the subject.

At the age of twenty, he took charge of the German army's rocket station. There, during World War II, he developed the V-2 rocket, which the Germans used to bombard London. When Hitler took personal control of the rocket work, von Braun was labeled as uncooperative and arrested on two main charges: 1) that he had been more interested in rocket development for space flight than for use as weapons by the Germans, 2) that he was guilty of treason because he was trying to escape to England. Later he was released because he was the only one who could head the V-2 production.

After the war, von Braun was invited to the United States to build rockets for the United States Army. He became director of NASA's George C. Marshall Space Flight Center in Alabama, where he directed development of the liquid-fueled rockets used in the United States program for space exploration. With von Braun's assistance, plans are being made for future space stations, colonies in space, and round trip journeys to Mars.

Suggested Activities

a. Discuss the fact that von Braun worked for both Germany and the United States. How might a scientist differ from a military man in his feelings about working for opposing governments? (For additional activities see page 52)

Source Materials

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ADDITIONAL ACTIVITIES

a. Class members might do independent reading to find out about the lives and contributions of men in some specific field. Individual reports could then be written. As a class project the reports could be collected and arranged so they trace the way in which an idea is developed. It will become apparent to the children that accomplishments are made through the contributions of many people.

b. Set up a display table of books, pictures, and related materials about the selected person whom the children are studying.

c. Compile a bibliography of biographical books and post it on the bulletin board. Have the students read and report on one or two of the books.

d. Have children pretend that they knew a famous person when he or she was young. Ask them to write a letter to the person as they might have then. Ask them to comment on events, (now historical), geography, etc.

e. Make a biographical time line.

f. Students could read about an important personage and prepare a "This Is Your Life" program.

g. Write newspaper articles concerning pertinent events in the life of an individual. This assignment could be combined with drawing cartoons or illustrations.

h. Children might prepare a news broadcast for an imaginary radio program.

i. Hold a panel discussion concerning some phase of the individual's life. Encourage children not on the panel to ask questions.

j. Make a scrapbook of newspaper and magazine articles and pictures pertaining to current or past "pioneers" in aerospace technology. This could be a class project or an individual activity.

k. Ask children to draw a series of pictures illustrating important events in the life of a well-known person. This activity helps children gain an awareness of chronology. The pictures could also be used effectively with an oral or written report.

l. Children might compose riddles after studying several biographies.

ARTIFICIAL SATELLITES AND SPACE PROBES

ARTIFICIAL SATELLITES AND SPACE PROBES

OVERVIEW

The beginning of the space age occurred October 4, 1957 when Russia launched Sputnik, the first artificial satellite. Soon thereafter the United States rocketed into orbit the Explorers, Vanguard, and other satellites equipped with scientific data-gathering instruments. Since these first launchings, several hundred satellites, interplanetary probes, and manned flights have been successfully launched by both the United States and Russia.

In organizing this book no attempt has been made to include each satellite and probe. Instead, they are grouped as follows: communications satellites, navigation satellites, weather satellites, scientific satellites, and interplanetary probes.

Teachers using the material in this section should watch for current happenings, and update the material, since each day brings new advances in space age accomplishments.

TABLE II: SATELLITE TIME LINE

COMMUNICATIONS SATELLITES

Date Launched		Name	Accomplishments
1958	Dec. 18	Project Score	Broadcast first voice message from space.
1960	Aug. 12	Echo I	First passive communications satellite; sphere used for passive communications and air density experiments.
	Oct. 4	Courier	First active communications satellite.
1961	Dec. 12	Oscar I	Broadcast practice signals for amateur radio operators.
1962	July 10	Telstar I	First satellite to relay television programs between the United States and Europe; cooperative project of NASA and American Telephone & Telegraph Co.
	Dec. 13	Relay I	Active relay for radio, telephone, and television.
1963	May 7	Telstar II	Higher apogee than Telstar I provided longer time for use. Radiation resistant.
	July 26	Syncom II	First satellite placed in synchronous orbit; designed for world-wide communications.
1964	Jan. 21	Relay II	Capability for transmission of television and telephone.
	Jan. 25	Echo II	Used in joint Russian-United States experiments.
	Aug. 19	Syncom III	Relayed telecasts of Olympic Games from Tokyo to the United States.
1965	April 6	Early Bird I	First commercial communications satellite; linked Europe and United States.
	April 23	Molniya I	First Russian communications satellite.
1967	Jan.	Lani Bird or Bluebird	First satellite for transpacific communication.
	March	Canary Bird	Improved transatlantic communication.

WEATHER SATELLITES

1959	Febr. 17	Vanguard II	First satellite to send weather information back to earth.
1960	April 1	Tiros I	First satellite to take detailed pictures of Earth's weather.
	Nov. 23	Tiros II	Took weather pictures and measured infrared rays given off by earth.
1961	July 12	Tiros III	Discovered Hurricane Esther over Atlantic. Collected good cloud cover data.
1962	Febr. 8	Tiros IV	Photographed Gulf of St. Lawrence. Supported Friendship 7 flight.
	June 19	Tiros V	Took good cloud cover pictures.
	Sept. 18	Tiros VI	Photographed weather conditions over flight path of Astronaut Walter Schirra.

WEATHER SATELLITES CON'T.

Date Launched		Name	Accomplishments
1963	June 19	Tiros VII	Took pictures of weather conditions; measured temperature and electron density in space.
	Dec. 21	Tiros VIII	Carried special camera system that transmitted pictures of clouds automatically.
1964	Aug. 28	Nimbus I	Tracked Hurricane Dora off Florida coast. Its camera, a refinement of the Tiros camera, always pointed to the earth. It had infrared cameras to take pictures of clouds at night.
1965	Jan. 22	Tiros IX	First Tiros "cartwheel" configuration for increased capability for photographing world cloud cover.
1966	Febr. 3	Essa I	Weather observation.
	May 15	Nimbus II	Similar to Nimbus I.
	Febr. 28	Essa II	Advanced version of cartwheel configuration. Permits local readout of daylight cloud cover.
	Oct. 2	Essa III	Similar to Essa II.
1967	Jan. 26	Essa IV	Similar to Essa II and Essa III.

SPACE PROBES

1959	Jan. 2	Luna I	Russia	Lunar probe, missed the moon and became the first spacecraft to orbit the sun.
	March 3	Pioneer IV	United States	Lunar probe, first United States probe to orbit the sun.
	Sept. 12	Luna II	Russia	First probe to strike the moon.
	Oct. 4	Luna III	Russia	Photographed the hidden side of the moon on Oct. 7, 1959.
1960	Mar. 11	Pioneer V	United States	Transmitted information on conditions more than 22.5 million miles in space. Gathered first solar flare and solar wind data.
1961	Aug. 23	Ranger I	United States	Gathered data on particles and fields.
	Nov. 18	Ranger II	United States	Same as Ranger I.
1962	April 23	Ranger IV	United States	First United States probe to strike the moon; failed to televise pictures to the earth.
	Aug. 27	Mariner II	United States	First interplanetary probe; found no magnetic field; passed near Venus on December 14, 1962.
	Nov. 1	Mars I	Russia	First Mars Probe attempt. Used solar cells. Television picture made of Mars.
1964	April 2	Zond I	Russia	Space probe for purpose of developing a space system for distant interplanetary flights.
	July 28	Ranger VII	United States	Televised 4,316 pictures of the moon.

SPACE PROBES CON'T.

Date Launched		Name		Accomplishments
1964	Nov. 28	Mariner IV	United States	Photographed Mars on July 14, 1965. First pictures ever taken in vicinity of another planet.
	Nov. 30	Zond II	Russia	Mars Probe. First use of ion engines for stabilization.
1965	Febr. 17	Ranger VIII	United States	Televised 7,137 pictures of the moon to the earth on February 20, 1965. Impact near the Sea of Tranquility.
	March 21	Ranger IX	United States	Televised 5,814 pictures of moon. The pictures showed evidence of volcanic activity.
	July 18	Zond III	Russia	Photographed the hidden side of the moon on July 20, 1965.
	Nov. 10	Venera II	Russia	Passed within 25,000 miles of Venus on Febr. 27, 1966.
	Nov. 16	Venera III	Russia	First spacecraft to hit Venus; crashed on March 1, 1966.
	Dec.	Pioneer VI	United States	Study of interplanetary phenomena.
1966	Jan. 31	Luna IX	Russia	Made first soft landing on the moon on February 3, 1966. Sent 9 pictures to the earth.
	Febr. 22	Cosmos	Russia	Carried two dogs for biomedical research. Capsule recovered after 22 days.
	March 31	Luna X	Russia	First spacecraft to orbit the moon; began orbiting on April 3, 1966.
	Dec. 20	Luna XIII	Russia	Landed on the moon in the Ocean of Storms. Test rod driven into lunar soil to determine firmness of surface.
1966	May 30	Surveyor I	United States	Landed on moon on June 2, 1966 in Ocean of Storms; sent 11.150 pictures to earth. Indicated that a spacecraft can touch down and men can walk safely on the moon.
	Aug. 10	Lunar-Orbiter I	United States	Began orbiting the moon on August 14, 1966. Photographed future landing sites.
		Lunar-Orbiter II	United States	Took "picture of the century,"---the crater Copernicius. Searched for landing site for spacecraft.
1967	April 3	Surveyor III	United States	Dug trench, scooped up soil from moon surface; soil was analyzed by television camera.
	May 4	Lunar-Orbiter IV	United States	Returned 6,315 pictures. Photographed both the visible and the hidden sides of the moon.
	June 12	Venus IV	Russia	Made soft landing on Venus.
	June 14	Mariner V	United States	Passed near Venus and collected scientific data.

SCIENTIFIC SATELLITES

Date Launched		Name	Country	Accomplishments
1957	Oct. 4	Sputnik I	Russia	First satellite to orbit the earth.
	Nov. 3	Sputnik II	Russia	Carried dog, Laika. Had instruments to measure cosmic rays, solar radiation, temperature and pressure.
1958	Febr. 1	Explorer I	United States	First United States Satellite; discovered Van Allen radiation belt.
	March 17	Vanguard I	United States	Discovered that the earth is pear-shaped.
	March 26	Explorer III	United States	Collected data on energetic particles and additional Van Allen Belt data.
	May 15	Sputnik III	Russia	
	July 26	Explorer IV	United States	Established spatial relationships and some properties of Argus radiation.
	Oct. 11	Pioneer I	United States	Studied radial extent of radiation bands, hydromagnetic oscillation.
	Oct. 22	Beacon I	United States	Studies atmosphere.
	Nov. 8	Pioneer II	United States	Indicated equatorial region had higher flux and energy levels than previously thought.
	Dec. 6	Pioneer III	United States	Discovered second radiation belt.
1959	April 13	Discoverer II	United States	First satellite with recoverable instrument capsule.
	Aug. 7	Explorer VI	United States	Mapped Van Allen radiation and transmitted cloud cover photos.
	Sept. 18	Vanguard III	United States	Surveyed Earth's magnetic field and the lower edge of radiation belt.
	Oct. 13	Explorer VII	United States	Gave data on radiation and magnetic storms.
	May 24	Midas I	United States	First surveillance test satellite.
1960	Nov. 3	Explorer VIII	United States	Confirmed existence of helium layer in upper atmosphere.
1961	Febr. 16	Explorer IX	United States	Atmosphere physics research.
	March 25	Explorer X	United States	Discovered interplanetary magnetic field near earth.
1962	March 7	OSO-1	United States	First orbiting solar observatory. First International satellite. Gave information of cosmic rays with earth latitude and intensity of radiation from Van Allen Belt.
	April 26	Ariel I	United States-Great Britain	Discovered ion belt at 450-500 mile altitude.
	Sept. 28	Alouette I	Canada	First Canadian satellite. Second International satellite recorded radiation belt effects.
	Oct. 31	Anna IB	United States	Carried flashing light to aid in mapping earth.
	Dec. 16	Explorer XVI	United States	Studied micrometeroids.
1963	April 2	Explorer XVII	United States	Discovered helium belt.
	Nov. 26	Explorer XVIII	United States	Confirmed existence of solar wind shock wave on magnetisphere.

SCIENTIFIC SATELLITES CON'T.

Date Launched		Name	Country	Accomplishments
1963	Dec. 19	Explorer XIX	United States	Polar orbit.
1964	March 27	Ariel II	United States-Great Britain	Sampled global distribution of ozone with an ultraviolet spectrometer.
	Aug. 25	Explorer XX	United States	Measurement of electron density distribution.
	Sept. 4	OGO-1	United States	First orbiting geophysical observatory. Studied earth-sun interplanetary space interrelationships.
	Oct. 4	Explorer XXI	United States	Detailed study of cislunar space.
	Oct. 10	Explorer XXII	United States	First use of laser tracking. Approximately 80 participating stations in 32 countries.
	Nov. 6	Explorer XXIII	United States	Meteroid detection satellite.
	Nov. 21	Explorer XXIV-XXV	United States	Studied air density.
	Dec. 15	San Marco I	Italy-United States	Italian project to test technology and provide experience for launching a similar satellite from a floating platform.
1965	Febr. 3	OSO-II	United States	Scanned the solar disc and part of corona.
	Febr. 16	Pegasus I	United States	Measured meteroid and micrometeroid density in space.
	April	Explorer XXVII	United States	Further study of Earth's gravitational field; laser tracking experimentation, continued ionospheric measurements.
	May 25	Pegasus II	United States	Near-earth micrometeroid environment data being obtained.
	May 29	Explorer XXVIII	United States	Continued IMP Study of solar-terrestial relationships.
	July 30	Pegasus III	United States	Last of Pegasus program. Removable "coupons" added for possible retrieval of thermal coating samples of degradation and cratering study.
1965	Oct. 14	OGO-II	United States	Similar to OGO-I but in nearly polar, low altitude orbit.
	Nov. 6	Explorer XXIX	United States	Intercomparison of satellite tracking systems accuracy.
	Nov. 19	Explorer XXX	United States	Monitoring of solar X-rays, correlated with optical and radio ground based observations.
		Geos	United States	Obtained information concerning earth's shape and size, gravitational field.
1966	April 8	OAO-I	United States	Orbiting Astronomical Observatory. Viewed heavens above earth's atmosphere for ultraviolet,X-ray, and gamma ray observations.
	May 25	Explorer XXXII	United States	Similar to Explorer XVII with solar cells for extended life.

SCIENTIFIC SATELLITES CON'T.

Date Launched		Name	Country	Accomplishments
1966	June 24	Pageos	United States	Obtained information concerning earth's shape and size, gravitational field.
1967	March 8	OSO III	United States	Conducted biological experiments in space.
	April 26	San Marco II	Italy	Launched from platform in Indian Ocean. Carried drag and ionospheric experiments.
	May 5	Ariel III	Great Britain	Studied atmosphere.
	May 24	Explorer XXXIV (IMP-F)	United States	Investigating region between magnetosheath and the solar wind shock front.
	July 19	Explorer XXXV	United States	Orbited moon to study radiation, the earth's magnetic field, and solar winds.

NAVIGATION SATELLITES

1960	April 13	Transit I-B	First navigation satellite.
	June 22	Transit II-A	Carried Canadian-built instruments to measure radio interference in space.
1961	Febr. 21	Transit III-B	First satellite to broadcast precise information on its own position.
	June 29	Transit IV-A	First satellite to use nuclear power.
	Nov. 15	Transit IV-B	Tested method of using earth's gravity to keep satellites in proper position.

AWAY WE GO

Topic

Launch vehicles

Background

A launch vehicle is any device that propels spacecraft and satellites into space. The rocket engine in a launch vehicle must apply a thrust large enough to lift the entire rocket, its control system, and the payload. As the fuel burns in the chamber, the gases expand and escape through the control nozzle at high velocity, creating a reaction in the opposite direction.

The future of space exploration depends upon the development of bigger and more powerful rockets capable of putting bigger and more complex spacecraft into orbit. Rockets in use today burn either solid or liquid fuel.

The United States has selected a fleet of launch vehicles to rocket various payloads into space. Some vehicles employed for NASA programs are:

Scout:	A solid-propellant launch vehicle, which can place a-240-pound satellite about 300 miles above the earth.
Delta:	A "work horse" NASA vehicle for a wide range of small payload missions.
Thor Agena:	A two-stage, 76-foot vehicle, capable of placing 1600 pounds into an orbit 300 nautical miles high.
Atlas D:	A two-stage liquid-propellant vehicle. It has three engines, all of which are ignited at launch. Atlas D can launch a satellite weighing 3,000 pounds into orbit approximately 100 nautical miles above the earth.
Atlas Agena:	A 91-foot-long, two-stage rocket vehicle which can place 5950 pounds into a 300 mile orbit, send 1,000 pounds to the moon, or rocket a 600-pound craft to Mars or Venus.
Atlas Centaur:	A two-stage launch vehicle. The upper stage is the first United States rocket vehicle to employ the high energy, liquid oxygen-hydrogen propellant combination. It generates about 40 per cent more thrust than is produced by the same weight of conventional rocket fuels, such as refined kerosene and liquid oxygen. Another feature of the second stage is that it can be stopped and restarted in space.

Titan II:	A Gemini launch vehicle that can be fueled well ahead of launch and need not be recycled (drained and refueled) if launch is postponed. Titan II stands 90-feet tall and can place a spacecraft weighing 8,000 pounds into orbit around the earth.
Saturn I:	A two-stage rocket which has been used to launch a mock-up of the Apollo command and service modules, and three Pegasus meteoroid satellites.
Uprated Saturn I:	The uprated Saturn I was designed to be used in the early stages of the Apollo Project.
Saturn V:	The world's most powerful launch vehicle. It was developed by the United States,and towers 365 feet over Cape Kennedy, Florida. Saturn V was developed for the Apollo lunar mission. Its first test took place November 9, 1967, and was an unqualified success.

The following chart gives examples of some of the projects for which these vehicles are used:

Delta:	Tiros, OGO, Essa weather satellites, Ariel, Orbiting Solar Observatories; larger Explorer and Pioneer satellites.
Scout:	Small Explorer satellites, ISIS, ESRO, San Marco.
Thor Agena:	Scientific satellites such as Alouette, Orbiting Geophysical Observatories, application satellites such as Advanced Echo, communications satellites and Nimbus weather satellite.
Atlas D:	Project Mercury, re-entry research.
Atlas Agena:	Unmanned lunar and interplanetary probes such as Ranger, Luna Orbiter, and Mariner, Orbiting Astronomical Observatory.
Atlas Centaur:	Surveyor spacecraft and advanced Mariner spacecraft for exploration of Mars and Venus.
Titan II:	Project Gemini.
Saturn I:	Project Apollo, earth orbital flights of mock-up Apollo command and service modules, Pegasus.
Uprated Saturn:	Earth orbital flights of complete Apollo spacecraft.
Saturn V:	Project Apollo lunar exploration mission; under consideration for Voyager.

Vocabulary

booster
burnout
command module
launch vehicle
Manned Spacecraft Center
mission control center
orbit
pay load
probe
propellant
propulsion
rendezvous
target vehicle
thrust
tracking network
trajectory

Suggested Activities

a. Have pupils find out about specific launch vehicles. Compile the following information about each: type, height, number of stages, type of propellant, purpose.

b. Have students make models of various types of launch vehicles. Note: In order for students to get a true comparison of the various types of launch vehicles, it will be necessary to have a common scale 1" = 10'.

c. Have a display of available launch models.

d. As a mathematics activity have children make graphs which compare United States launch vehicles.

Source Materials

Books

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Launch Vehicles, Vol. II, #5 t
United States Launch Vehicles, Vol. II, #5 t
Saturn V, Vol. IV, #5 i. t.

Films

Road to Stars, USAF i
Rockets and Satellites, 13½ min. United World Films i

Filmstrips

Thor Missile Story, Society for Visual Education, Inc. i

Slides

Launch Vehicles, NASA

Table Top Display

Launch Vehicles, NASA

Transparencies

Typical Rocket, (3 overlays) #258-518, General Aniline Film Corp. p. i.
Rocket Engines, #528-521, General Aniline Film Corp. p. i.
Ion Rocket, (3 overlays) #258-522, advanced, General Aniline Film Corp. i

Charts

How Big are Missiles, Communicative Arts i

Photographs

Rocketry, Group F, NASA i

Records

By Rocket to the Moon, Y. P. R., 437-78 rpm i
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MECHANICAL BRAINS IN SPACE

Topic

Operation of man-made satellites

Background

Almost from the beginning of the space age, satellites, with automated instruments aboard, have been significantly advancing man's frontier of knowledge and blazing a trail for eventual manned exploration of the moon and other celestial bodies. These satellites have explored in space at distances ranging from the earth's upper atmosphere to the vicinity of Venus and Mars. The International Geophysical Year (IGY) which began in 1957, led to the launching of the first scientific satellites.

The first United States man-made satellite, the Army's Explorer I, was launched on January 31, 1958,carrying eleven pounds of instruments. This Explorer was forty inches long and six inches in diameter. Its Geiger counters recorded the number of cosmic rays per second at six hundred miles altitude, but at one thousand miles altitude intense radiation jammed the instrument. Thus, the lower Van Allen Radiation Zone was discovered. Other Explorers observed part of the inner Van Allen Belt, micrometeorites, solar radiation outbursts, the ionosphere, magnetic fields, and high energy gamma rays. Explorer VI took the first crude television pictures of the earth. It was the first "paddle wheel" satellite. The paddle wheels contained solar cells which used sunlight to produce electrical power.

Vanguard I, launched by the Navy on March 17, 1958, went into an orbit four hundred ten miles above the earth at the lowest point, and two thousand four hundred fifty miles at the highest point. This satellite was a metal sphere, six inches in diameter, weighing 3¼ pounds. Due to its low atmospheric drag and exceptionally high orbit, scientists expect Vanguard to stay in orbit for many decades.

Satellites employ an ingenius system of collecting and transmitting information. Data collected by the various instruments is stored in the memory unit. Then the data is electronically transmitted to the radio, causing variations in the beep-beep of the radio signal. Receiving stations record the signals on magnetic tape recorders. The tape, in turn, is used to produce a visible pattern of jagged lines on film. From this pattern of lines, scientists read the information which the satellites collect.

Among the instruments used in a satellite is a thermometer known as a "thermistor". It is a tiny metal disk mounted on the outside of the satellite. An erosion gauge is a detector to learn more about the meteors encountered in space. Another method of detecting meteors is to place a microphone inside the shell of the satellite. It records the ping of the meteors or any other object which strikes the satellite. The Geiger counter is used to detect cosmic rays. When a cosmic ray goes through it, the ray triggers the release of an electric impulse.

Clusters of Geiger counters are used to indicate the direction of the cosmic rays. A spectrometer is used to separate a beam of electromagnetic radiation into its spectral components as a prism separates the white light of the sun into the spectrum. It is used to study the infrared and ultraviolet spectrum in the stars and planets. Attempts to study the interplanetary magnetic field are made by using instruments called magnetometers. Intensity of radiation from planets is measured by infrared radiometers. A topside sounder is designed to study irregularities in the ionosphere.

Vocabulary

altitude
cosmic ray
detector
erosion
gamma rays
gauge
Geiger counter
interplanetary
ionosphere
magnetic fields
magnetometers
micrometeoroids
microphone
photoelectric
radiation
satellite
solar-cell panels
spectometer
spectrum
sounding rockets
telemetering
thermistor
tracking
Van Allen Radiation Belt

Suggested Activities

a. Make pictures or models of both Explorer and Vanguard satellites.

b. Have the class design a satellite and indicate what instruments they would put into it.

c. Each student could be assigned at least one type of satellite (depending upon the size of the class, you may want to assign two types of satellites to each student). Each student should collect the following information on each satellite: type, height, weight, what it does, and the information it has collected. At the conclusion of the activity each student could report on the information about his satellite.

d. Have a few children make a chart on satellites for classroom reference.

e. Let children illustrate satellites. They may wish to animate the drawings, giving them creative titles or captions. Children may tell or write imaginary stories about what their satellite saw or heard while in space. Their stories could be put on tape for the listening center.

f. Have a demonstration of a Geiger counter (Contact local high school science teacher).

Source Materials

Books

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Earth Satellites, Explorers of Outer Space, 17 min., b/w, Encyclopedia Britannica i
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COMMUNICATIONS SUPERHIGHWAY

Topic

Communications satellites

Background

Of all the types of artificial satellites, the communications satellite may have the most direct impact on everyday life. These satellites have provided the means for developing an unlimited global communications system. Television already depends heavily on transmission via satellite. Soon virtually unlimited intercontinental telephone communications will be possible.

Score is considered to be the first satellite of this type, though strictly, it was not a communications satellite. Score and Courier, another of the early communications satellites were both delayed repeater satellites; they received information from one part of the earth and stored the message on a tape recorder for later transmission on command. President Eisenhower's Christmas message to the world had been recorded prior to take-off on Score and later was transmitted to Earth. This was the first "voice from space". This type of satellite was abandoned in favor of instantaneous repeater satellites.

Echo I, the first true communications satellite, is called a passive satellite because it simply is used to bounce a signal received from one point on the earth to another point. Echo I and II contributed to the acquisition of information needed to develop equipment for an operational communications satellite system.

Telstar and Relay are active repeater satellites because they receive, amplify and re-broadcast messages. These satellite projects, launched in medium-altitude orbits, were initiated by private enterprise. Telstar provided the first transmission of live television across the Atlantic Ocean. Relay transmitted many public telecasts.

Syncom, another active repeater satellite, was the first satellite to revolve in a synchronous orbit. In a synchronous orbit, a satellite revolves at a rate which will keep it above a fixed point at all times, making the satellite appear to be stationary. The successful performance of the Syncom satellites led to the founding of the Communications Satellite Corporation which patterned its first commercially operational communications satellite, Early Bird, after the Syncom.

Lani Bird was designed to provide the first regular transpacific communications by satellite and at the same time to provide communications support for the Apollo program. Canary Bird, a synchronous communications satellite, improved communication over the Atlantic.

The potential of communications satellites is great. Satellite systems have the capacity for providing direct dialing to all parts of the world. Possible future uses include international conferences on television flashed to countries all over the world via satellite. A global information retrieval system where information from the world's great libraries can be flashed to researchers in any country, is another future prospect for communications satellites. Global dissemination of medical and meterological data will also be possible. Echo I was used to demonstrate a speed mail system through the use of machines to open letters, scan contents and transmit the contents via communications satellites. There are possibilities that satellite communications may be used for directing ship and aircraft traffic. Such a system can help direct spacecraft and locate spacecraft during re-entry. Such a system could be used in rescue operation on both land and sea. This new satellite technology also provides possibilities for greater understanding and cooperation among the people of the world.

Vocabulary

- apogee
- Blue Bird
- cable
- Canary Bird
- capacity
- communication
- Courier
- delayed repeater satellite
- Early Bird
- Echo
- impact
- instantaneous
- Lani Bird
- microwave
- passive
- perigee
- rebroadcasting
- recorder
- relay
- repeater satellite
- satellite
- Score
- signals
- stationary satellite
- sychronous orbit
- syncom
- Telstar
- transmission
- transoceanic

Suggested Activities

a. Develop a bulletin board which illustrates the ways in which world-wide communication can be accomplished.

b. Use a gyroscope to show how satellites are stabilized through a spinning motion.

c. Use a slinky to illustrate how sound travels.

d. Show the process of communication by making a graph or time line of communication, from the smoke signals of the past to the satellites of today.

e. To develop an understanding of the future uses of communications satellites, show how they can provide communications for the entire world.

f. Have the children think of ways they may receive benefits from the satellites.

g. To make satellites:
Take the lower portion of a salt box, leave pouring spout on box to represent the camera used on satellite, cover box with blue construction paper. Use small strips of masking tape to represent the panels between the solar cells on the outer surface of the satellite. Fill the box with tissue paper or Kleenex. Insert toothpicks into box to represent antennae on the satellite.

Source Materials

Books and Pamphlets

Adler, Irving and Adler, Ruth, Communications, New York: John Day Co., 1967 p. i.
Asimov, Isaac, Satellites in Outer Space, New York: Random House, 1964 p. i.
Dietz, David, All About Satellites and Space Ships, New York: Random House, 1962 p. i.
Dunlap, Orrin E. Jr., Communications in Space, New York: Harper & Row, 1964 t
Jaffe Leonard, Communications in Outer Space, New York: Rinehart, and Winston Inc., 1966 t
Solomon, Louis, Telstar, Communications Break Through by Satellite, New York: McGraw Hill Book Co., 1963 i t.
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Challenges of Space Age, E. P. 21, 1963 t
NASA Communications Satellite
Project Relay, G. 12, 1962 t
Project Syncom, C. 5, 1963 t
Space: The New Frontier, 1967, NASA, U. S. Govt. Print. Office, Wash., D.C.

Films

Communication: Lifeline to Space, USAF, 20 min,
Communications Satellites, 12½ min. Film Association i (advanced)

Photographs

Satellites and Space Probes, NASA Group E. i

Records

Journey to the Moon; and Now About Outer Space, LP 158, 33 1/3 rpm, Golden
Project Telstar, Communicative Arts, i
Space Songs MR-0312,

Chart

Telstar Satellite, Communicative Arts

EVERYBODY TALKS ABOUT IT

Topic

Weather satellites

Background

In the past, weather forecasters would not attempt to predict weather conditions more than one or two days in advance. Since the entire atmosphere is a single interacting mass of air, weather men needed to know what was happening over the entire earth before they could make accurate long-range forecasts.

The first United States weather satellite was Vanguard II, launched February 17, 1959. Although it produced no usable weather data, the experience gained led to the development of Tiros.

Tiros I was launched April 1, 1960. Tiros, which stands for Television and Infrared Observation Satellite, is an 18-sided polygon. Its sides and top are covered with solar cells which, when exposed to the sun's rays, produce the electrical power to recharge the 63 nickel-cadmium batteries. Tiros takes pictures and transmits them to Earth for interpretation by meteorologists. It also detects and measures infrared radiation reflected by the earth's atmosphere, and reports this data by telemetry.

Tiros IX is tilted on its axis and resembles a cartwheel rolling along an imaginary track. It was launched in polar orbit rather than an east-west orbit. It is so placed that the sun is always behind it during the daytime. This provides plenty of light for picture taking.

Tiros IX is the forerunner of the joint NASA and U. S. Weather Bureau effort named ESSA. ESSA stands for Environmental Science Service Administration and is now managed and financed by the Weather Bureau. ESSA I, a Tiros-like satellite, was launched February 3, 1960. ESSA V was launched April 20, 1967.

The Nimbus satellite was designed to observe the entire earth. Its cameras and other sensors always point toward the earth. It has two solar paddle wheels which turn on shafts to make it possible to keep the paddles directed toward the sun. The first Nimbus was launched August 28, 1964. It was equipped with television cameras which had high resolution infrared observation capabilities. This made it possible to take pictures both day and night. Infrared equipment uses heat radiation instead of light to take pictures. Land is warmer than clouds and appears dark in the infrared picture.

Nimbus II also has equipment for measuring the earth's heat balance. Heat balance refers to how much of the sun's radiation is absorbed by the earth and how much it reflects back into the atmosphere. This may increase understandings of how storms are born, develop and die.

Weather satellites have been extremely valuable in warning people of approaching storms and in improving the accuracy of weather prediction. They are also assisting in the exploration of space.

Vocabulary

analyze
apogee
atmosphere
balance
contamination
cyclone
forecaster
elliptical
ESSA
heat balance
hurricane
infrared rays
meteorology
Nimbus
observation
perigee
polar orbit
prediction
radiation
radiometer
resolution
satellite
solar cells
sphere
Tiros
tornado
transmit
Vanguard
weather bureau

Suggested Activities

a. Children might report on the activity of various weather satellites.

b. Using various musical instruments (or improvise other sound) have children produce the auditory interpretation of a thunderstorm.

c. Take a field trip to a local weather station or invite a meteorologist to come and talk to the children.

d. Have children listen to radio or television, or check newspapers for daily weather reports. Keep a record of the times predictions have been accurate.

e. Have the children learn symbols for rain, snow, clouds and thunderstorms. Use these symbols in making weather maps.

f. Find pleasing forms in clouds. Using tempera, paint a picture of a sky you might see on a stormy day. Crayon and tempera may be used on colored construction paper for topics such as: "Lightning and Rain," "The Storm Gathers Above Us," "It's Dark and Windy Outside," "Cold and Snow in Winter."

g. Study prints of paintings such as:
   Homer's - "The Fog Warning" or "The Gulf Stream"
   Pieter Brugel's - "Summer," "Autumn," "Winter"
   Keyonaga's - "Sudden Shower"

h. Make a weather satellite model. Materials needed are: coffee can, 2 wooden dowels (1" diameter), tempera paint (blue, white) coat hanger, art paper.

Puncture coffee can on bottom with four holes. Insert wire, pipe cleaners or dowels to represent antennae. Cut art paper necessary size to cover sides of can. Paint paper in blue and white checker board pattern to resemble solar cells. Discuss satellite's contribution and future possibilities.

i. Another type of satellite can be made from the following materials: styrofoam ball 6" dia., pipe cleaners, aluminum paint. Paint styrofoam ball blue, paint pipe cleaners with aluminum paint, insert pipe cleaners along 3 axes.

Source Materials

Books

Bonsall, George, The How and Why Wonder Book of Weather, New York: Grossett and Dunlap, Inc., 1960 p. i.
Dietz, David, All About Space Ships and Satellites, New York: Random House, 1962 i.
Hyde, Margaret, Exploring Earth and Space, New York: McGraw Hill Book Co., 1963 i.
Ley, Willy, Harnessing Space, New York: Macmillan Co., 1963 i.
Sonneborn, Ruth A., Space, New York: Random House, 1965 i.
Widger, William K. Jr., Meteorological Satellites, New York: Holt Rinehart, and Winston Inc., 1966
NASA Facts: Supt. of Documents, U. S. Government Printing Office, Washington, D. C. or address Regional NASA Center; for Nebraska Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058
  Nimbus Vol. II, No. 7
  Tiros, Vol. II, No. 12
NASA Space: The New Frontier, 1967
NASA Meteorological Satellites

Films

Tiros - Experimental Weather Satellite, 14 min., color, NASA t
Tiros II - Experimental Weather Satellite, 6 min., color, NASA t

Filmstrips

What Makes the Weather?, Eye Gate Inc., Jamaica, New York, 11435 i.
Fundamentals of Science Set III - Weather, Eye Gate
NASA Meteorology from Space, Series I, 35 min. No. FS 660104 (with tape or record 33 1/3 rpm)

Transparencies

Tiros, Weather Satellite, #258-524, General Aniline and Film Co. p. i.

Record

Journey to the Moon and More About Outer Space, Golden Record, 33 1/3 rpm, LP 158 p

Table Top Display and Slides

NASA Meteorology From Space (Expanded in accordion manner with printed narration)

Flannel Board

#70 U. S. Weather Map) School Specialty Supply
#272 Water Cycle)

Map

Weather Map #WM-460. T. N. Hubbard Scientific Co., North Brook, Illinois i

PIONEERING IN SPACE

Topic

Scientific satellites and probes

Background

A satellite is a body which orbits another body. The moon is a natural satellite of the earth. Scientists have placed many artificial satellites into orbit around the earth and around the moon. In the future it is possible that satellites may travel into outer space and orbit other planets.

The term "probe" is applied to unmanned capsules which travel into interplanetary space for the purpose of making observations about conditions there. They frequently go into solar orbit after transmitting information to Earth.

Man is anxious to know and understand more about solar winds, radiation, magnetic fields, micrometeoroids, and other phenomena of our solar system. The satellites and probes which are being launched almost daily will provide much of this information.

The series of Explorer satellites comprise the largest group of scientific satellites in the United States space program. These are small satellites carrying a limited number of experiments. Their design and orbit are determined by their mission. Some have been put into orbit to measure air density in the upper atmosphere; some have been designed to study the ionosphere and to provide information about micrometeoroids. Interplanetary Explorers are a special class in this series designed to provide data on radiation and magnetic fields between the earth and the moon. This information is necessary in order to protect astronauts who will be traveling to the moon. Other Explorers are transmitting information about the solar wind and the Van Allen radiation belt.

Project Discoverer is the result of a long and intensive program in research, manufacture and testing. A Discoverer was the first American satellite to be placed in a polar orbit, to be controlled in orbit, to carry and eject a recovery capsule, and to carry heavy pay loads. The first launching was February 28, 1959, seventeen months after Sputnik I. This has been a United States military program, the main contribution of which was the development of technology for recovery of packages, sent from an orbiting satellite to earth.

Pioneer was NASA's first series of interplanetary probes. The Pioneers investigate phenomena in space between Earth and the moon, between Earth and Venus, and between Earth and Mars. Pioneer I was launched in 1958. Pioneer III discovered the Van Allen Radiation Belt, named for Dr. Van Allen of the State University of Iowa. Pioneer IV is considered a "man-made planet", as is Russia's Lunik I, since it went past the moon and orbited the sun. The most notable of the series was Pioneer V which went past Venus and is still orbiting the sun.

The Pegasus satellite, named for the winged horse of Greek mythology, was among the heaviest and largest orbited by the United States. The satellite was 71 feet long and 14 feet high, with wings which opened like an accordion to a span of 96 feet. The wings of Pegasus were designed to report information about the micrometeoroids which struck them. Pegasus satellites have advanced man's understanding of space and are helping scientists decide what will be necessary in a craft designed for prolonged space travel.

The Biosatellite is the first United States spacecraft launched for the purpose of determing the effects of prolonged space travel on living organisms, ranging in size from tiny, single-cell creatures to monkeys. Six flight models have been planned.

Vocabulary

bacteria
biology
Biosatellite
Discoverer
Explorer
Geiger counter
interplanetary
launch
meteoroids
meteorites
meteors
micrometeoroids
orbit
organisms
Pegasus
Pioneer
photoelectric
probes
puncture
satellites
sensor
solar
specimen
spin-stabilized
transmitting
Van Allen Radiation Belt

Suggested Activities

a. On the chalkboard keep a list of questions about satellites which require research. Once a week use these as a basis for your science class discussions.

b. Read to the class an informative article about satellites. Then ask them to write as much as they can remember from their listening. The article might also serve as an opportunity to practice note-taking.

c. Have each pupil decide on a specific type of satellite and construct a model of it from scrap material.

d. Each child may explain to the class the purpose of his satellite, and the function of its various parts.

e. Children might write a newspaper article describing a specific satellite and its mission.

f. Children may enjoy writing jingles and rhymes about some of the satellites. "Twinkle, Twinkle Little Star" could be used to set a pattern if a lead is necessary.

Source Materials

Books

Berganuni, David, The Universe, Life Nature Library, New York: Time Inc., 1962 i
Branley, Franklyn M., A Book of Satellites for You, New York: Thomas Y Crowell Co., 1958 D/T p. t.
Deitz, David, All About Satellites and Space Ships, New York: Random House, 1962 p. i.
Dunlap, Orion E., Jr., Communications In Space, New York: Harper and Row, 1964 t
Etting, Mary, Space Craft at Work, New York: Harvey, 1966 p. i.
Highland, Dr. Harold J., Planets and Interplanetary Travel, New York: Grosset & Dunlap, 1962 p. i.
Hyde, Margaret O., Off Into Space, New York: McGraw Hill i
Hynoff, Edward, Guidance and Control of Our Aircraft, New York; Rinehart, Holt, Winston Inc., 1966 t
Jacobsen, Willard J., Lamby, Cecila J., Raniecek, Richard D., Exploring the Solar System, New York: American Books Co., 1965 i
Kramer, Saunders, Chester M., Discoverer Story of a Satellite, New York: G. P. Putnam's Sons, 1960 i
Ley, Willy, Missiles, Moon Probes, and Megaparsecs, New York: The New American Library, 1964, a Signet Science Library Book, i
Schneider, Leo, Space in Your Future, New York: Harcourt, Brace and World Inc., 1961 t
Yates, Raymond T., Russell, M. E., Space Rockets and Missiles, New York: Harper and Row Pub., Inc., 1960 i
Young, Richard S., Extraterrestial Biology, New York: Holt, Rinehart and Winston, Inc., 1961 t

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Fact Sheets: Facts-Biosatellites, Vol. II, No. 10 t
Pegasus, Vol. II, No. 15 t
Interplanetary Explorer Satellites, Vol. II i
Explorer XIX, Vol. II, No. 2 t
Explorer XVI, Vol. iv, No. 4 t
Ranger Vol. III, No. 2

Films

NASA Earth Satellites Explorers of Outer Space, #1686 i

Filmstrips

Adventures in Space

Record

Space Songs, What is a Shooting Star? Motivation Record
Voices of the Satellites, Folkway Record, Fr. 6210, Folkway Record and Services Corp.

Slides

NASA Know Your Satellites, with printed narration 35 min.

Transparencies

The Moon #22-E 3 M Company p.

Table Top Displays

NASA Know Your Satellites

STREET CAR SATELLITES

Topic

Scientific observatory satellites

Background

For centuries astronomers have worked with telescopes observing the objects in the skies. Perfection of the telescope has made it possible to make very complex studies of nearby stars and planets, but the haze of the atmosphere is a tremendous hindrance to what can be seen through these powerful telescopes. The development of satellites has now made it possible for telescopes to be put into space where their view is not hindered by our atmosphere. The sights that they observe there are transmitted back to earth by television cameras, giving astronomers tremendous new possibilities for learning about the universe.

The purpose of the Orbiting Astronomical Observatory (OAO) was to gain information about the structure, evolution and composition of celestial bodies. OAO made it possible to observe the universe without interference from the atmosphere. It was a 3,900 pound satellite carrying 1,000 pounds of instruments. Two silicone solar paddles and nickel cadmium furnished power to the satellite. The OAO was lost after two days. A second OAO is planned, probably for launch in 1968.

A series of satellites has been designed to provide information about the sun and solar phenomena from a point above the disruptive forces of the atmosphere. This series is called the Orbiting Solar Observatory. The first OSO was launched March 7, 1962; it travels in a nearly circular orbit. It receives its power from solar cells. OSO carries fifty instruments and to date has identified sixty two elements in the sun.

The Orbiting Geophysical Observatories (OGO) were designed to increase knowledge about the earth and space and how the sun affects them. OGO I was launched September 4, 1964; OGO II was launched October 14, 1965. Each carried twenty different instruments and made observations of numerous phenomena for prolonged periods of time. There are two types of OGO satellites: Eccentric Geophysical Observatory (EGO) traveling in east-west orbit, and Polar Orbiting Geophysical Observatory (POGO) which is studying the atmosphere and ionosphere over the north and south poles. POGO was launched July 30, 1967.

Vocabulary

apogee
astro-
celestial
eccentric
EGO
electrons
galactic
gamma rays
geo-
interstellar
magnetosphere
observatory
OGO
orbit
OSO
perigee
photometer
POGO
protons
silicon
spectrometer
spectrum
Van Allen Radiation Belt
X-rays

Suggested Activities

a. For a study of acronyms plan a bulletin board featuring the names of several satellites. For example one might use the following:

Scientific Satellites	Communications Satellites	Weather Satellites
Orbiting	S	Television
Solar	Y chronous	Infra
Observatory	N	Red
	C	Observation
	O munications	Satellite
	M	

b. A bulletin board might be developed by displaying astronomy-related pictures with their Greek or Latin names. Children could list familiar words which have derived from the root. For example: display pictures of a star ("astron"); the sun ("sol"), the earth ("geo'). Beneath the appropriate picture list words such as "astronomy," "solar" and "geography." Encourage children to learn more about word derivation.

c. Report on the influence which solar radiation will have on space travel.

d. Report on various types of solar radiation, making certain to include the earth's Van Allen Radiation Belt.

e. Collect and reproduce as many symbols of the sun as you can find. (i. e. Old Hopi Indian sun god, Konarok; Indian Sun Wheel, Buddhist sun medallion.)

f. To gain greater understanding of latitude and longitude, use maps or globes to locate observatories and tracking stations around the world. Show their relationship to each other.

g. To develop skill in expository writing, explain in three or four paragraphs what the following standarized satellites are accomplishing or are expecting to accomplish: OAO, OGO, and OSO.

Source Materials

Books

Branley, Franklyn *The Sun-Star Number One*, New York: Thomas Y. Crowell Co., 1964 t.

Keen, Martin, *Wonders of Space*, New York: Grosset and Dunlap, 1967 t. i.

Ley, Willy, *Harnessing Space*, New York: Macmillan, 1963 t. i.

May, Julian, *Rockets*, New York: Follette Publications, 1967 t. i.

Naugle, John E., *Unmanned Space FLight*, New York: Holt, Rinehart and Winston, Inc., 1965 i.

Schneider, Leo, *Space In Your Future*, New York: Harcourt, Brace and World Inc., 1961 i

United States Aircraft, Missiles and Spacecraft, National Aerospace Education Council, 616 Shoreham Bldg., 806 15th St., Washington, D. C. 20005

NASA Facts: National Aeronautics and Space Administration, Supt. of Documents, U. S. Government Printing Office, Washington, D. C., or address regional NASA Center; for Nebraska-Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058

Orbiting Geophysical Observatory, Vol. II, No. 13

Orbiting Solar Observatory, B-62, T II

Space, The New Frontier, U. S. Government Printing Office, 1967 t. i.

Films

Orbiting Solar Observatory, 26 min., color, NASA

Records

Space Songs, *Why Does the Sun Shine?* from Ballads for the Age of Science by Hy Zaret and Lou Singer, Motivation Records # 0312 p. i.

EYES IN THE SKY

Topic

Geodetic satellite

Background

The launching of Vanguard I catapulted the science of geodesy into a new era. Geodesy is the science which deals with the size, shape and mass of the earth, the variation in the earth's gravity, and the measurement of locations on the earth. Satellites have provided volumes of new information about the earth. The equipment they carry has measured air density, solar winds, layers of the atmosphere, micrometeroids, the magnetosphere and numerous others. When Vanguard was placed in orbit scientists noted an irregularity in its orbit. The irregularities were thought to be due to the force of the earth's gravity,and the uneven distribution of the earth's mass. This led to the determination that the earth is slightly pear shaped.

The satellite studies of the earth from space have shown that the equator is elliptical instead of circular. High and low areas in relation to mean sea level have been revealed by a rise and fall in satellites' orbits. These hills and valleys are thought to be the result of stresses inside the earth. Scientists are also finding answers to questions concerning continental drift and ocean currents. Fault areas in the earth are being detected. Infrared cameras can determine temperature of the ocean waters at various points. Satellites are also giving weather forecasters advanced information about storms and hurricanes.

Infrared photography can detect diseased trees in forests and orchards. By the same means, schools of fish can be located in the ocean. These are only a few of the contributions geodetic satellites are making to the world.

Vocabulary

- active
- altitude
- area
- continental drift
- earth
- Explorer
- fault
- geodesy
- geodetic
- geology
- gravitational field
- ground resolution
- inflatable
- infrared
- navigation
- oceanology
- octagonal
- passive
- stabilization
- triangulation

Suggested Activities

a. Obtain pictures taken from space and try to distinguish mountains, water, roads, buildings,etc.

b. Discuss films and slides taken by Gemini astronauts.

c. Mathematics problems can be devised in relation to some aspects of information obtained from earth satellites. For example:

Problem I

On a photograph taken from an artificial satellite show that a highway that is forty feet wide would be just visible as a thin line 0.02 of an inch wide in the photograph. If the picture is 4" by 5" in size what is the actual size of the area shown?

Solution: Because the highway 40' wide is barely visible on the photograph scientists say the "ground resolution" of the photo is 40'. Since 40' on the ground corresponds to 0.02 of an inch on the photograph, the 5" picture will show an area 10,000' in length and 8,000' in width.

$$\frac{40' \times 5}{.02} = 10{,}000' \qquad \frac{40' \times 4}{.02} = 8{,}000'$$

The area shown in the photo is 10,000' x 8,000' = 80,000,000 sq. ft. or 2.9 sq. miles.

Problem II

Suppose that an object on the earth's surface 3' in diameter is just visible on a satellite photo as a dot 0.01" wide. How long would a series of dots on photos have to be in order to show the entire United States, which is approximately 3,000 miles from coast to coast?

Problem III

Identify different kinds of angles and the use of degrees in angular measurement. (See NASA Fact Sheet "Explorer XXIX" Vol. iii, No. 4 for use of triangle in mapping). Practice addition and subtraction of degrees of angles. For example:

- Examine several types of projections and types of maps. Discuss the purpose of each. Discuss what changes might be made after receiving more information from satellites.

Source Materials

Books

Asimov, Isaac, Satellites in Outer Space, New York: Random House, 1964 p. i.

Adler, Irving, Seeing the Earth from Space, New York: Random House, 1961 t. i.

Hyde, Margaret O., Exploring Earth and Space, New York: McGraw Hill Book Co., Inc., 1963 i

Naugle, John E., Unmanned Space Flight, New York: Holt, Rinehart and Winston, Inc., 1965 t

Space The New Frontier, Washington, D. C., U. S. Government Printing Office, 1967 t

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Table Top Displays

NASA, Geology from Space

Magazines

Conrad Pet Cooper, Gordon, The Earth Seen from Gemini 5, Life, Vol. 59, No. 15, September, 1955, Pages 30-40

Film

A Space Flight Around the Earth, Churchill Films i

Filmstrips

Geology from Space, Series I, F. S. 651206, color, 15 min. with record NASA

Record

Space Songs #0312, Nasco Science Materials

Chart

Astronauts View of the Earth, Communicative Arts i

WAY OUT COOPERATION

Topic

International satellites

Background

The cooperation of various nations in the exploration of space may be a step toward cooperation in a peaceful world community. Joint projects of interest to many nations are being carried out. Since 1958 many nations have cooperated in the exploration of space.

Ariel I, a cooperative project of the United States and the United Kingdom was the world's first international satellite. It was launched by NASA on April 26, 1962. Ariel was designed for the purpose of contributing to man's knowledge of the ionosphere. Ariel II, launched March 27, 1964, contained three British-built experiments.

Echo II was the first satellite to be used in cooperation with the Soviet Union. It was launched on January 25, 1964.

Alouette, named for a song bird of the lark family, was launched on September 29, 1962. It was the first satellite built by a nation other than the United States or the Soviet Union.

San Marco I was launched on December 15, 1964. It was an Italian satellite instrumented to measure air density and investigate characteristics of the ionosphere that affect long range communications. The San Marco II was launched April 26, 1967, from a platform in the Indian ocean.

Canada's Alouettes I and II, the French FR I and the Italian San Marco provided scientific data for International Quiet Sun Year (IQSY). These studies were conducted during the period when the sun was relatively free of solar flares, sun spots,and other eruptions. This program, conducted from January 1964 to December 1965, was a sequel to the International Geophysical Year (IGY) project which was a world-wide study of the sun and earth.

The European Space Research Organization (ESRO) was set up to build, launch, and monitor satellites and launch rockets. Belgium, Denmark, France, Federal Republic of Germany, Italy, Spain, Netherlands, Sweden, Switzerland, and the United Kingdom are members of this organization.

International Satellites of Ionospheric Studies (ISIS) were built by Canada and launched by the United States. The first ISIS satellite was launched November 28, 1965. After it was in orbit, it became known as Alouette II. Three additional ISIS satellites are planned.

United States scientists are cooperating with other countries in communications, meteorlogical, and biological programs. The Communications Satellite Corporation (COMSAT) is now launching satellites for world-wide communication. The World Meteorological Organization, a specialized agency of the United Nations, has established World Weather Watch, an international system.

Vocabulary

Alouette
communications
cooperation
electron
ion
ISIS
international
ionosphere
meteorology
mutual
proton
tracking

Suggested Activities

a. Have children write paragraphs or essays on the implications of cooperation in space for the future of the world.

b. After listening to Edgar Varese's "Ionization", have children bring or make their own percussion instruments. Encourage them to express their own interpretation of ionization.

c. Have children report on the specific activities of Ariel and Alouette, sounding rockets, radio communications, or other international space projects.

d. Have pupils locate on maps or globe the cooperating nations listed in unit.

e. Plan a cooperative space mission. Children from "different countries" can build a model spacecraft, with each country making its own contribution.

Source Materials

Books

Dietz, David, All About Satellites and Space Ships, New York: Random House, 1962 i
Ley, Willy, Harnessing Space, New York: McMillan, 1963 t
Naugle, John E., Unmanned Space Flight, New York: Holt, Rinehart, and Winston Inc., 1965 t
Yates, Elizabeth, Rainbow Round the World, New York: Wilson, 1954 t
NASA Facts, Supt. of Documents, U. S. Government Printing Office, Washington, D. C. or address Regional NASA Center; for Nebraska= Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058
Ariel-First International Satellite (c-62) t
Alouette, Canada's First Satellite (F-12-62)
Space: The New Frontier

Films

Alouette Canada's First Satellite, 14 min. b/w, NASA t

Ariel, The First International Satellite, 13 min. color, NASA t
International Cooperation in Space, 23 min. color, NASA

Record

Music by Edgar Varese "Ionization", Columbia- M. L. 5478

PROBING SPACE

Topic

Probes to the Moon, Venus, and Mars

Background

An impressive scientific effort is being made to explore our solar system with unmanned space probes and satellites. Scientists are extremely anxious to get data about the other members of our solar system to satisfy man's age-old curiosity about the nature of the universe in which we live, and hopefully, to learn more about the origins and development of our own planet. The moon is the first goal in our space exploration. It may contain the answers to many scientific questions about the development of the earth. Through study of the surface of the moon which has not been subjected to the erosive forces of an atmosphere, it is hoped that we will be able to understand how the surface features of the earth evolved. It is entirely possible that exploration of the planets, some of which may be much older or much younger than the earth, will unlock many more of nature's secrets.

The first step in actual exploration of the moon was to obtain high resolution pictures of the moon by means of Project Ranger. This project contributed the greatest advance in lunar knowledge since Galileo first studied the moon through a telescope. Ranger spacecraft telecast 17,255 close-up pictures of the moon, revealing features as small as 10 inches across. These pictures provided evidence that the moon's surface is smooth enough for landing of manned spacecraft. This program was concluded in 1965 after nine flights.

The question of surface hardness and strength is now being determined by Surveyor. The first Surveyor was intended primarily to test a soft landing technique using legs instrumented to return information on the hardness of the moon's surface. Each leg carried a single scanning television camera. Surveyor I was launched May 30, 1966, arriving June 2, 1966. It telecast thousands of close-ups of the surface surrounding it. Surveyor II, launched April 3, 1967, had a hand-sized scoop which dug a two inch trench in dry, grainy soil. The tests indicated that the soil is firm enough to support a spacecraft such as the planned Apollo.

The Lunar Orbiter series are designed to orbit the moon and return close-up pictures and information on the amount of radiation near the moon and the presence of micrometeoroids. This information will contribute to preparing the way for the Apollo missions. The first Lunar Orbiter was launched August 10, 1966. Lunar Orbiter V was launched August 1, 1967.

Mariner is a series of spacecraft designed to fly in the vicinity of Venus and Mars and send back information about these planets. Mariner II, launched December 15, 1962, gave man his first relatively close-up study of Venus. Mariner IV, launched July 14, 1965, reached the vicinity of Mars and snapped the first close-up pictures ever taken of another planet. Mariners II and IV provided much information about interplanetary space as well as about the planets. A modified Mariner IV flew close to Venus in October 1967. Additional Mariner flights are planned for 1967 and 1969.

Spacecraft called Voyagers will orbit Mars, and transmit information to Earth. Some of the Voyagers will contain instrumented capsules which will land on the surface. Scientists hope that these instrument capsules will obtain information regarding the existence and nature of life on Mars,its atmosphere, and surface characteristics of the planet. These flights are scheduled for launch about 1970.

Vocabulary

Apollo
atmosphere
capsule
crater
data
dense
environment
exploration
extraterrestrial
instruments
interplanetary

lunar
magnetic field
Mariner
Mars
micrometeoroids
orbit
origin
periodic
probes
project
radiation

Ranger
scanning
Surveyor
surface
technique
telecast
telescope
transmit
Venus
vicinity
volcanic activity
Voyager

Suggested Activities

a. An art project on a theme such as "We are Exploring the Surface of Venus," may be done in tempera paint and India ink batik. The animals or the plant life which the child imagines will be found there could be the main subject of the picture.

b. Have the children write down what the words "ranger", "surveyor," "lunar" and "orbiter" mean to them. Show and discuss Ranger and Surveyor transparencies. See how many children wrote meanings which fit the ideas expressed on the transparencies.

c. Use vermiculite to simulate the surface of the moon. The children could bombard the vermiculite with marbles or objects of different sizes to show how the craters were possibly formed by meteorites. A background could be made of black construction paper with pin holes for stars.

e. Draw maps of the moon and put in the landing sites of various lunar probes.

f. Read Miss Pickerell on the Moon to the class. Have the children illustrate scenes from the story and write titles or paragraphs about their pictures.

g. Discuss recent developments in the moon exploration project. Sources of information are recent newspapers, magazines, and news broadcasts. Compare the surface pictures of the earth with those of the moon.

h. Keep a scrapbook of newspaper clippings of recent developments in moon and planetary exploration.

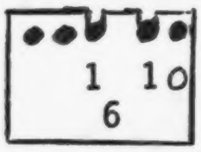
i. Pupils might like to become familiar with the concepts of the binary number system and the computer by using a game. Since the launch of August 27, 1962, Mariner has sent about ninety million bits (from binary digit, meaning a unit of information) to earth. (See following page for directions)

Source Materials

Books

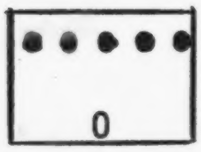
Asimov, Isaac, Satellites in Outer Space, New York: Random House, 1964 p. i.
Branley, Franklin M., Exploration of the Moon, Garden City, New York: Natural History Press, 1964 i
Brenna, Virgilio, The Moon, New York: Golden Press, 1963 i
Dunlop, Orrin E. Jr., Communications in Space, New York: Harper and Row, 1964 t
Hyde, Margaret O., Exploring Earth and Space, New York: McGraw Hill Book Co., Inc., 1963 i
Jet Propulsion Laboratory, Mariner: Mission to Venus, New York: McGraw Hill, 1963 t
Jet Propulsion Laboratory, The View From Ranger
Lessing, Lawrence, Forty Miles of Information Every Day from Space, New York: Fortune, January, 1964 i
Ley, Willy, Harnessing Space, New York: McMillan Co., 1963 i
Ley, Willy, Missiles-Moon Probes and Megaparsecs, Signet Science Library Books, New York: The New American Library of World Literature Inc., 1964 i
McGregor, Ellen, Miss Pickrell on the Moon, New York: McGraw Hill, 1965 p. i.
Naugle, John E., Unmanned Space Flight, New York: Holt, Rinehart, and Winston, 1965 i
Space: The New Frontier, NASA, Supt. of Documents, U. S. Government Printing Office, Washington, D. C.
Stambler, Irwin, Project Mariner, New York: Putnam and Sons, 1961 i
Travel, How and Why Wonder Book, New York: Grosset, Dunlap, 1963 p

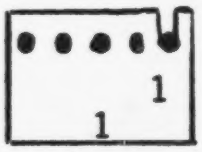
i, Materials needed: Sample card

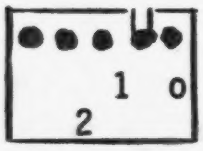


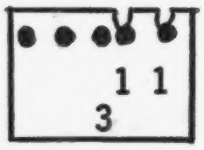
Making cards:

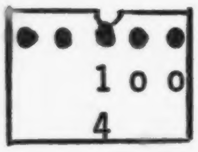
All holes punched in the cards must correspond. Below each hole, number the cards using the base two number, as indicated in the sample card. Where the number one appears, cut the hole as indicated in the sample card. In the center of each, number the cards from 0-11 using base 10 number.

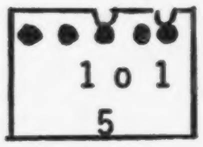


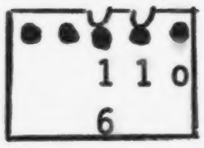


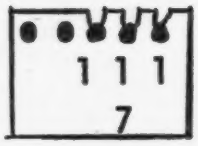


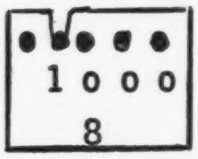


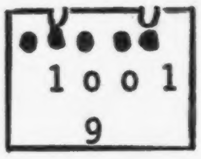


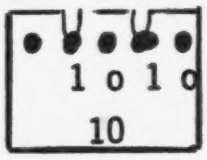


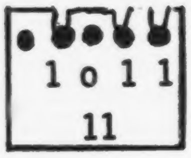












Base 10 0123456789	Base 2 0,1
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
11	1011

Playing the game:

Step 1. Have one student shuffle the cards.

Step 2. Teacher takes the pin and inserts it through the holes in column one, making sure that the pin goes through all cards.

Step 3. Teacher slowly lifts the pin shaking cards. The cards that remained on the pin are brought forward and combined with the "dropped" cards.

Step 4. Proceed to the hole above column two using the same procedure that was carried out in step 1.

Step 5. Continue this procedure until the pin has been in all holes, making sure that you always move over one column each time. When you have finished, you will have arranged the cards in numerical order.

Note: If the cards are not in numerical order shuffle them and begin again. Be sure to shake the cards thoroughly, and be sure to place the "dropped" cards behind those which remain on the pin.

Magazines

True Color of the Moon, Life, Vol. 61, No. 1, July 1, 1967, pp. 62-69
Right Down on the Moon, Life, Vol 60, No. 6, February 11, 1966, pp. 26-35
NASA Facts, Supt. of Documents, U. S. Government Printing Office, Washington, D. C.; or address regional NASA Center; for Nebraska: Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058
  Mariner d-62 t
  Mariner V Report, NFB-4-63 t
  Mariner IV, Vol. II, No. 9 t
  Project Ranger, Vol. III, No. 2 t

Films

The Clouds of Venus, 27 min. color NASA
Earth Satellites: Explorers of Outer Space, 17 min. color #1938 b/w #1939 Encyclopedia Britannica Films
Ranger VII, Photographs of the Moon, 7 min. b/w NASA
Ranger VIII, Television pictures of the moon, 6½ min. b/w NASA
Ranger IX, Television pictures of the moon, 6½ min. b/w NASA
A Trip to the Moon, 17 min. color Encyclopedia Britannica Films

Filmstrips

Space Travel (Satellites) Walt Disney, I

Transparencies

Ranger VII Flight to the Moon (288-541) General Aniline and Film Corp. i.
Mariner II Flight to Venus (258-575) General Aniline and Film Corp. i.
Destination Mars, The Red Planet (258-260) General Aniline and Film Corp.
The Moon #22 E 3 min. p

Photographs

Satellites and Space Probes - Group E, NASA i

Study Prints

Moon Exploration: Part I - Instrumented, Communicative Arts, i

Records

A Wagner Program, Tannhauser: Overture and Venusberg Music (Bacchanale), The Philadelphia Orchestra, Eugene Ormandy Conductor, Columbia
Holst, Gustav, The Planets, Venus (The Bringer of Peace), Los Angeles Philharmonic Orchestra, Leopold Stokowski, Conductor, Capitol

MANNED SPACE FLIGHT

MANNED SPACE FLIGHT

OVERVIEW

Since the beginning of time, man has been curious about the mysteries of space. Man's dream of penetrating the earth's atmosphere and exploring the universe is becoming a reality.

Thus far, the United States and Russia are the only two nations in the world which have conducted successful manned space flights. The exploration of space is important to the United States in maintaining the national security, and in retaining its place among the world's leaders in science and technology. The manned space flight experiments have demonstrated that the planned trip to the moon, the assembly and repair of craft in space, and the maintenance and operation of manned space stations are within the capabilities of today's technology.

Undoubtedly many students of today will be directly involved in future space explorations. Therefore, it is very important for teachers to increase their knowledge about space and space travel and to motivate children to learn about it.

SPACE MENAGERIE

Topic

Animals in space

Background

The scientists who were working on the early manned space flights had many problems which needed answers before a man could be put into space. Some of these problems were: Would the acceleration needed to get into space be too great for man to endure? How would cosmic radiation affect a living being? Would the effect of vibration and shock be too great? Would meteoroids harm the spacecraft? Could man function in a weightless condition? Could he be protected from the extreme temperatures of space?

In order to find answers to these problems, test animals were put into space. Putting animals into space is not a new idea. Before the Frenchman Rozier, ascended in his balloon in 1783, a sheep, a duck, and a rooster were sent up and recovered safely. The first attempt to send living organisms into space took place in 1946 when the National Institute of Health sent spores to the outer limits of our atmosphere. The spores were exposed to cosmic radiation but were never recovered. The next year, a container of fruit flies, boosted to an altitude of one hundred and six miles, was recovered. In early experiments with animals, rockets carried monkeys, cats, and dogs to the extreme limits of the atmosphere.

World attention was focused on exploration of space when the Soviet Union launched Sputnik I on October 4, 1957. On November 3, 1957, Russia launched Sputnik II with a dog named Laika aboard. Information about the dog's condition was transmitted by instruments aboard the spacecraft. This information was received, interpreted and used as a basis for making space travel safer for man. In 1960, the Soviet Union sent two dogs, Belka and Strelka, into space. They were the first two living beings to be returned to Earth from orbit.

The United States conducted most of its experiments with monkeys and chimpanzees. Chimpanzees are much closer to man physiologically, intellectually, and anatomically than any other animal. The chimps were carefully selected and trained by Air Force veterinarian specialists. On May 29, 1959, two monkeys, named Able and Baker, were placed aboard a Jupiter launch vehicle and rose to an altitude of three hundred miles, at a speed of ten thousand miles per hour. Able was a seven-pound rhesus monkey and Baker was a one-pound squirrel monkey. The monkeys were successfully recoverd and much valuable information was gained from the flight. Unfortunately, Able died a few days later as a result of an anesthetic given when an electrode was removed from under the skin. Baker was given a home at the Pensacola Naval Air Station where visitors can view her.

A test program known as "Little Joe", a part of the Mercury program, was initiated a few months later to provide additional information for manned space flight. On December 4, 1959, a rhesus monkey named Sam was placed aboard a rocket which traveled fifty five miles into space. Sam's ride was a success and he was safely recovered. The second "Little Joe" flight took place January 21, 1960, when Miss Sam successfully tested the escape system to be used in manned flight aboard a Mercury capsule. On January 31, 1961, a Mercury-Redstone rocket boosted a capsule containing a chimp named Ham, to an altitude of one hundred and fifty seven miles. He was trained to push different levers to match circles and squares on a screen. When he made a correct response, he was rewarded with a banana-flavored pellet and when he made a mistake he received a mild electrical shock. Ham proved that an animal can perform certain tasks in space. Enos, a five year old, forty-two pound chimp, orbited the earth twice on November 29, 1961. Enos was able to perform many functions in space. His success was an indication that training methods employed with chimpanzees were most effective. After this flight, John Glenn was ready for America's first manned orbital space flight.

Vocabulary

acceleration
anatomy
anesthetic
ascended
cosmic
design
electrode
exposed
intellect
meteors
orbiting
pellet
physiology
radiation
response
rhesus monkey
specialist
spores
transmit
veterinarian
vibration

Suggested Activities

a. Find out about the work of veterinarians in space research.

b. Find out why the United States used chimpanzees and monkeys for space experiments.

c. Plan and make a book or bulletin board called "Animal Astronaut Hall of Fame."

d. Play a response game. Two players, a time keeper, and four cards are needed. On two of the cards draw circles; draw squares on the other two. One of the players holds up a card and the other player matches it. See how many correct responses can be made in a minute. (One of the chimps was able to make 100 correct responses in a minute.)

Source Materials

Books

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Bergwin, Clyde and Coleman, William, Animal Astronauts, New Jersey: Prentice Hall, 1963 i. t.

Burt, Olive, The Space Monkey - The True Story of Miss Baker, New York: The John Day Company, 1960 i.

Em[illegible] Eugene, A History of Space Flight, New York: Holt, Rinehart an[illegible]nston, Inc., 1965 t.

Highland, Harold, The How and Why Wonder Book of Planets and Interplanetary Travel, New York: Nobel and Nobel Pub., 1962 t.

Rey, H., Curious George Gets a Medal, New York: Houghton Mifflin, 1957 p.

Todd, Ruthven, Space Cat Visits Venus, New York: Charles Scribner's Sons, 1955 p. i.

Zack, Irene, Space Alphabet, New York: Prentice Hall, 1964 p.

DO YOU WANT TO BE AN ASTRONAUT?

Topic

Astronaut selection

Background

The criteria used for astronaut selection is determined by the particular requirements of the mission for which they will be trained. Selection is the responsibility of the NASA Manned Spacecraft Center in Houston, Texas. Public announcements concerning the requirements for each group, and the periods during which applications will be received are also controlled by the Manned Spacecraft Center.

Astronauts must have adequate ability, experience, and education to enable them to learn the many intricate details of space flight mission. They must be in excellent health and have the physical stamina to endure many stresses and strains. They must be able to evaluate a situation and act quickly. They must possess tremendous self-control and be able to remain alert after hours of confinement and tension.

Jet pilots who wish to be astronauts must have a bachelor's degree in engineering or physical or biological science. Scientists with doctoral degrees in the natural sciences, medicine, or engineering are also eligible to become astronauts. They need not be pilots but later are taught to fly jet aircraft. All candidates must be United States citizens, be six feet or less in height, and must be within the age limit. Requirements have changed since the Mercury astronauts were chosen in 1959 and will probably change again as demands increase for specified areas of competence.

The applicants are given thorough physical examinations and extensive testing at the Manned Spacecraft Center. The tests are both physical and psychological. One of the psychological tests that has been used is entitled "Who Am I?" The applicant has to answer the question "Who Am I?" in twenty different ways. The answers give clues to the motives for his desire to join the space program. Another test requires the applicant to sit in the "Idiot Box" which is full of flashing lights and sounding buzzers. The applicant is to make correct responses to the signals in five seconds. The prospective astronauts' reaction to silence is also determined by requiring them to spend several hours in a dark, soundproof isolation room.

The physical tests for astronaut candidates are very thorough. At least seventeen different eye tests are given. The men walk on treadmills, ride a wheelless bicycle, and repeatedly step on and off of a twenty-inch step. Blood pressure and pulse are checked constantly during these tests. The men are also placed in a heat chamber (135 degrees) for two hours, and then their feet are suddenly submerged in ice water to measure shock reaction and blood pressure response. The men spend two hours in a chamber at a simulated altitude of sixty-five thousand feet; again their pulse rate and blood pressure are checked. A ride on the centrifuge is also included in the physical tests.

Perceptual tests and reaction time tests are also important parts of the astronaut selection process. Applicants are carefully tested in these areas because extremely accurate vision and very fast reaction time are absolutely necessary for the many complex tasks performed by the crew on a manned space mission.

The men who hope to be selected for the space team must meet very stringent physical, mental, emotional and educational requirements so that when final selection of astronauts is made, NASA is assured of having extremely capable men.

Vocabulary

altitude chamber
blood pressure
centrifuge
cones of the retina
confinement
detect
manual dexterity
perception
psychological
reaction
repetition
responses
self-control
situation
tactile receivers
treadmill

Suggested Activities

a. The "Who Am I?" test could be completed by the children. Let the children try out some of the other tests, such as stepping on and off of a twenty-inch step several times. Caution the children not to over-exert themselves.

b. Urge the children to discuss the way in which personality is an important factor in the selection of an astronaut. The children could describe the personalities of people they like.

c. Set up a mock selection board for astronaut selection.

d. Write biographies of some astronauts who have been selected for the program.

e. This is a game to check your reaction time. How fast can you react? See how long it takes to touch each square in numerical order. Time yourself on the number of seconds it takes to complete the test.

4	3	10	12
6	11	8	9
1	7	2	5

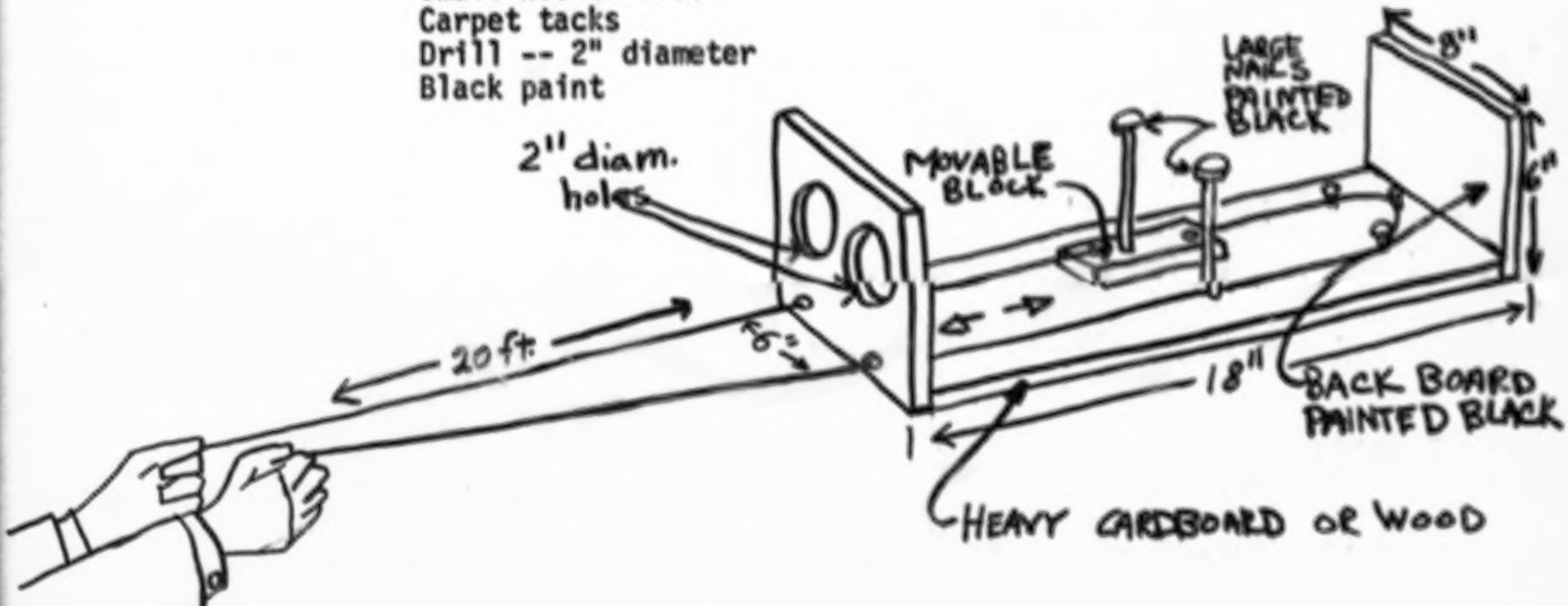
9 seconds? Your reflexes are about average
7 seconds? Very good.
5 seconds? Excellent.
More than nine seconds? Your reaction time is too slow.

Note: Above test taken from Science Digest, May 1, 1965.

f. Maneuverings of spacecraft in techniques of rendezvous and docking can be greatly facilitated by excellent depth perception. Construct the apparatus illustrated below. Use it for depth perception testing as directed. Prepare a chart of the performance of each individual in your group--allowing for at least three attempts per individual. Determine if depth perception can be improved by repetition of the activity. Describe types of activities in which astronauts would need good depth perception.

Materials needed:

One piece of wood -- 18' x 6' x 3/4'
Second piece of wood -- 8' x 6' x 3/4'
Four wood screws approximately 1¼' long
String -- 45' long
Two nails
Small wooden block
Carpet tacks
Drill -- 2" diameter
Black paint



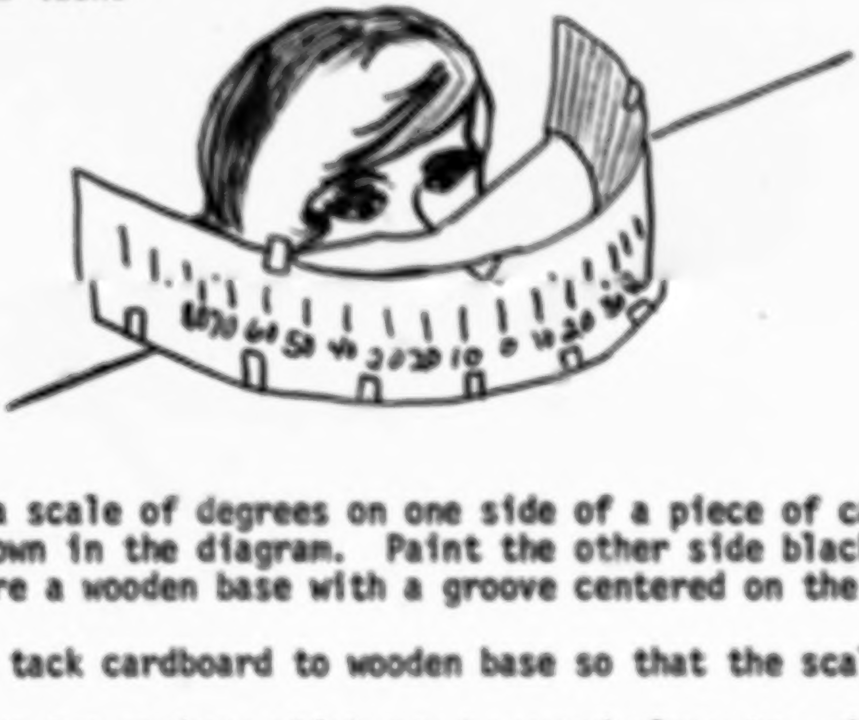
1. Assemble apparatus as shown in the diagram.
2. Clamp it to edge of table and extend strings to approximately 20 feet.
3. Use a chair which allows the person being tested to sit with his eyes at the same level as the holes in the apparatus.
4. Using a ruler, add a scale to the center of base board as shown.
5. Sit on the chair, hold one string in each hand, and attempt to line up nails as quickly as possible.

g. Locate tactile receivers. Have a subject close his eyes and have another person touch his upper arm with two pencils. At the same time ask the subject how many pencils he felt. Continue touching the subject down the inside of his arm until you reach his fingertips. Try the same process on the lips with toothpicks. Observe where most of our tactile receivers are located.

h. Location and operation of instrumentation in a spacecraft is partially dependent upon the width of the astronauts' field of vision. You can determine the width of the field of vision with the apparatus illustrated below. Using it, answer the following questions: Do both eyes usually have the same field of vision? What effect does wearing glasses have? What effect do contact lenses have? What astronaut activities are dependent upon field of vision?

Materials needed:

Strip of cardboard 45" by 4"
Metal or wire clips
Marker or pen
3/4" wooden base cut in ½ circle with 18" radius
Black paint
Ruler
Thumb tacks



1. Make a scale of degrees on one side of a piece of cardboard as shown in the diagram. Paint the other side black.
2. Prepare a wooden base with a groove centered on the outer edge.
3. Thumb tack cardboard to wooden base so that the scale is facing out.
4. Prepare two markers which can be moved along top edge of the cardboard.
5. The pupil being tested should sit so that his nose is in the groove on the baseboard; he should look directly at 0 marker while markers are moved along scale until they disappear from view. Stop moving each marker at the last spot where pupil can see it.
6. Read number of degrees as field of view for each eye.

i. Use the following activity to demonstrate the problems involved in viewing objects in space. Arrange about 30 pairs of dots on a black background. Each dot in a pair should be 1/16" apart. Observe the dots from a distance of 20 to 30 feet. Now observe the dots from a distance of 3 or 4 feet. At a short distance the dots appear as they are, but at a great distance they appear as a straight line. The cones of the retina separate the dots at a short distance. At great distances the image strikes the same cone or two neighboring cones on the retina, and this prevents separation of the dots.

Source Materials

Books

About Yourself, Chicago: Scott, Foresman and Co., 1959 p. i.
The Astronauts Themselves, We Seven, New York: Simon and Schuster, 1962 t.
Bell, Joseph N., Seven Into Space, Chicago: Popular Mechanics Company 1960 i.
Henry, James P., Biomedical Aspects of Space Flight, New York: Holt, Rinehart and Winston, Inc., 1966 t.
Singer Science Experiments, Syracuse, New York: L. W. Singer Co., Inc., 1959 i.
Wyler, Rose and Baird, Eva-Lee, Science Teasers, New York: Harper and Row, 1966 p. i.
NASA Facts, Educational Brief #10013, Astronaut Selection, National Aeronautics and Space Administration. Supt. of Documents, U. S. Government Printing Office, Washington, D. C. or address Regional NASA Center, for Nebraska: Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058

Record

Flight of Friendship Seven and the Astronaut, Mercury Records

ASTRONAUTS GO TO SCHOOL, TOO!

Topic

Astronaut training

Background

One of the important phases in the manned space flight program is training astronauts to operate the spacecraft and to be able to make the scientific observations required of them on space flights. There are two basic divisions in the program: general training and specific mission training. Much of the current training for Apollo missions is based on knowledge gained from the Mercury and Gemini programs. The astronaut training program includes:

I. General Training

  A. Academic Program
    (1) Geology
    (2) Astronomy
    (3) Digital computers
    (4) Flight mechanics
    (5) Meteorology
    (6) Guidance and navigation
    (7) Physics of the upper atmosphere
    (8) Cape Kennedy briefings on launch preparation and countdown operations
    (9) Briefings on the facilities at the Marshall Space Flight Center and the Mississippi Test Facility
    (10) Mission Control Center briefings on the operation and facilities at the Manned Spacecraft Center
    (11) Briefings on the recovery program for the Apollo spacecraft
    (12) Instruction in each of the Apollo spacecraft systems

  B. Environmental and Contingency Training
    (1) Weightlessness practice in a modified KC 135 flying a parabolic trajectory and in a tank of water
    (2) Acceleration in a large centrifuge to simulate the g force experienced in various phases of the mission
    (3) Pressure suit familiarization
    (4) Survival training in tropic and desert areas and on water

  C. Study of spacecraft and launch vehicle design and development

  D. Aircraft Flight Program
    (1) Flying T-33 and T-38 to support engineering and training activities
    (2) Helicopter flying to familiarize astronauts with lunar landing trajectories

  E. Physical Training

II. Specific Mission Training (Six to nine months before launch date)

A. Mission Simulator Training

B. Docking Training

C. Egress Training (for post-landing procedures)

D. Celestial Navigation and Scientific Experiments Training

Vocabulary

abort
acceleration
celestial
centrifuge
contingency
docking
egress
maneuver
propulsion
rendezvous
simulator
trajectory
weightlessness

Suggested Activities

a. Discuss why team cooperation is essential in the space program as well as in our daily lives.

b. Have class discussions about the importance, thoroughness of,and reasons for the astronaut training program.

c. Record impressions of an astronaut experiencing weightlessness, acceleration or learning survival techniques in the desert, tropics, or ocean.

d. Make a roller movie of the astronaut training program.

e. Plot on a map all the places where astronauts train.

f. Imagine you are an astronaut and write pages in a diary or write a letter to your parents telling them about your activities.

g. Dramatize aspects of the astronauts' training.

h. In imaginary "space suits" practice walking, bending, etc.

i. Make a "simulator" for practice in flying a spacecraft.

j. Use cutouts of Apollo modules on the overhead projector to show rendezvous and docking procedures. Refer to Figure 10, page 122.

k. Make a chart outlining the training program.

l. Do research on the effects of space travel on man.

m. Discuss motives that drive men to join the space program. Hold mock interviews with the astronauts.

n. Compare the backgrounds of the space pioneers with other famous pioneers and explorers.

o. Write biographies of: Christopher Kraft, Jr. (MSC Assistant Director for Flight Operations), the astronauts, and the scientist-astronauts.

p. Learn about special aspects of the Apollo training program such as the 328-foot-wide simulation of the moon's rugged surface and the "moon trip" simulators.

q. Find out about other career opportunities on the aerospace technology team. Also, seek information on the possibilities of women becoming astronauts.

Source Material

Books

Branley, Franklyn M., A Book of Astronauts for You, New York: Crowell, 1963 p. i.
Henry, James P., Biomedical Aspects of Space Flight, New York: Holt, Rinehart, and Winston, 1966 t.
Myrus, Don., The Astronauts, New York: Grosset and Dunlap, 1963 i.
Scharff, Robert, Into Space with the Astronauts, New York: Grosset and Dunlap, 1965 t.
NASA Facts, Astronaut Training #10014, National Aeronautics and Space Administration, Supt. of Documents, U. S. Government Printing Office, Washington, D. C. or address Regional NASA Center; for Nebraska - Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058
Aerospace Arithmetic, A Supplement for Elementary Arithmetic, National Aerospace Education Council, 616 Shoreham Building, 806 15th St N. W., Washington, D. C. 20005

Filmstrips

Getting Ready for a Space Trip, Jam Handy Organization p. i.
How An Astronaut Lives in Space, Filmstrip House p. i.
Into Outer Space, #A606, Curriculum Materials Corporation i.
Man in Space, #484-3, Society for Visual Education i.
Man Travels in Space, #131-F, Eye Gate House, Inc. i.
Space Flight, Part I, Physical Problems, McGraw-Hill Text Films i.
Space Flight, Part II, Human Problems, McGraw-Hill Text Films i.

ONE, TWO, THREE---THE MOON

Topic

Projects Mercury, Gemini, and Apollo

Background

One of the initial steps in the long-range program for manned exploration of space was Project Mercury, a series of missions which sent a capsule carrying one man into near space and into low earth orbits. Project Gemini, the second step in the manned space flight program, sent two-man capsules into earth orbit to develop techniques for use in the Apollo Project. In 1968, Project Apollo, carrying three-man crews will begin the United States effort to put men on the moon.

The Apollo mission has been planned in three steps. Step one was the placement of unmanned test models of the Apollo command and service modules, into earth orbit. These tests, using the Saturn I launch vehicle, were completed July 30, 1965. The second step started on February 26, 1966, with the successful suborbital test flight of the Uprated Saturn I--Apollo combination. The next phase of the project will include a series of test launchings of the Saturn V carrying an Apollo capsule. The entire assembly weighs six million pounds at launch and stands 365 feet tall.

The first manned Apollo launch is planned for 1970. These first flights will be a series of earth orbital flights to check out equipment and techniques. In approximately 1972 the actual exploration of the moon will begin.

The spacecraft used in the Mercury, Gemini and Apollo Projects are depicted in Figures 1 through 4. A chart summarizing details about each project is included with the Figures. The Apollo spacecraft is made up of three separate parts or modules as depicted in Figure 5. At blast off the three parts will be united to form an integral unit. The crew will travel in the command module which contains the guidance and communications equipment. The service module contains the main propulsion system for return from the moon and for course corrections. It also houses propellant tanks and the electrical system, reaction control systems, and part of the environmental control system. The lunar module is located below the service module. In the initial phases of the mission, the LM is simply a passenger,cradled inside of the SLA (the spacecraft lunar-module adapter). It is stored inside the SLA until the lunar exploration phase of the mission begins.

The steps in the trip to the moon and the return to earth are depicted in Figures 6 through 9.

Vocabulary

Apollo
docking
ejection
extravehicular
function
Gemini
g-load
jettison
lunar
manned
Mercury
module
objectives
orbital
rendezvous

Suggested Activities

a. Have the children draw their conceptions of all three capsules.

b. Later, as the children share their pictures, have them take time to think about going up in one of the capsules. Which one would it be? Why? Let them tell their stories. Perhaps a story chart could be made for each type of capsule.

c. Compare the height, width and weight of the Mercury, Gemini and Apollo spacecraft

d. Compare the launch vehicles used for each of the three capsules.

e. Make lists of the basic goals of the Mercury, Gemini and Apollo projects.

f. Write and produce a dramatic play relating to the trip and the landing on the moon.

g. Make papier-mache moons.

h. Make charts of the Ranger and Surveyor spacecraft projects. Much of what we know about the moon has come from these projects.

i. On a mural contrast the environments surrounding: a cart, a jet plane, and a space ship.

j. Create views from a spaceship using different media.

k. Make space helmets and a rocket ship for creative play.

l. Have the children make puppets and plan a puppet show about a space story.

m. Have children improvise conversation from spaceship to earth.

n. Draw up a list of space related words suggesting action. Use for example: orbiting, rotating, launching, etc. Have children act out the motions suggested by these words.

o. Make individual word lists of compound words using the noun, moon, e. g., moonshine, moonbeam, moonstruck, moon-faced, moonlight, moonstone, etc.

p. Encourage children to become better informed and have them bring articles and pictures about lunar probes and space exploration. Display information obtained from all communication media.

q. Write creative stories about space trips and moon visits.

r. Refer to Figure 10. These drawings may be traced or cut out and used as patterns. Each child, working with his own Apollo, can demonstrate launch, rendezvous, orbit, and jettison.

s. Have class compose rhymes about space pioneers of today. Set verses to familiar tunes.

t. Have chilren use creative dance to interpret ideas such as: "The Moon that Disappears Behind a Cloud," "Space Ships," and "Take-off, Orbit, and Re-Entry Phases of the Astronauts' Flight".

Source Material

Books

Alexander, Thomas, *Project Apollo: Man to the Moon*, New York: Harper and Row, 1964 t.
Branley, Franklyn M., *A Book of Astronauts for You*, New York: Crowell, 1963 p. i.
Chester, Michael, *Let's Go On A Space Trip*, New York: Putnam, 1963 p. i.
Coombs, Charles, *Project Apollo: Mission to the Moon*, New York: Morrow, 1965 i. t.
Elting, Mary, *Spacecraft at Work*, New York: Harvey, 1965 i.
Stoiko, Michael, *Project Gemini*, New York: Holt, Rinehart and Winston, 1963 t.
Sutton, Felix, *The How and Why Wonder Book of the Moon*, New York: Grosset, 1963 i. t.
NASA Facts: *Manned Space Flight: Apollo*, Vol. IV, No. 7
Space: The New Frontier, NASA, 1967
National Aeronautics and Space Administration, Supt. of Documents, U. S. Government Printing Office, Washington, D. C. or address Regional NASA Center; for Nebraska - Educational Programs and Services AP4, NASA Manned Spacecraft Center, Houston, Texas 77058

Films

A Trip to the Moon, Encyclopaedia Britannica Films i.
First Men Into Space, Encyclopaedia Britannica Films i.
Gravity: How It Affects Us, Encyclopaedia Britannica Films i.
Space Science: An Introduction, Coronet Instructional Films i.

Filmstrips

Getting Ready for a Space Trip, Jam Handy Organization. p. i.
How An Astronaut Lives in Space, Filmstrip House. p.
Our Moon, Filmstrip House, p.
Space Trip to the Moon, Jam Handy Organization. p. i.

Records

Flight of Friendship Seven and The Astronaut, Mercury Records
Journey to the Moon and More About Outer Space, Golden Records

Transparencies

Space Age Science Projecto-Aid Transparencies created by McGraw-Hill Information and Training Services, General Aniline and Film Corp.

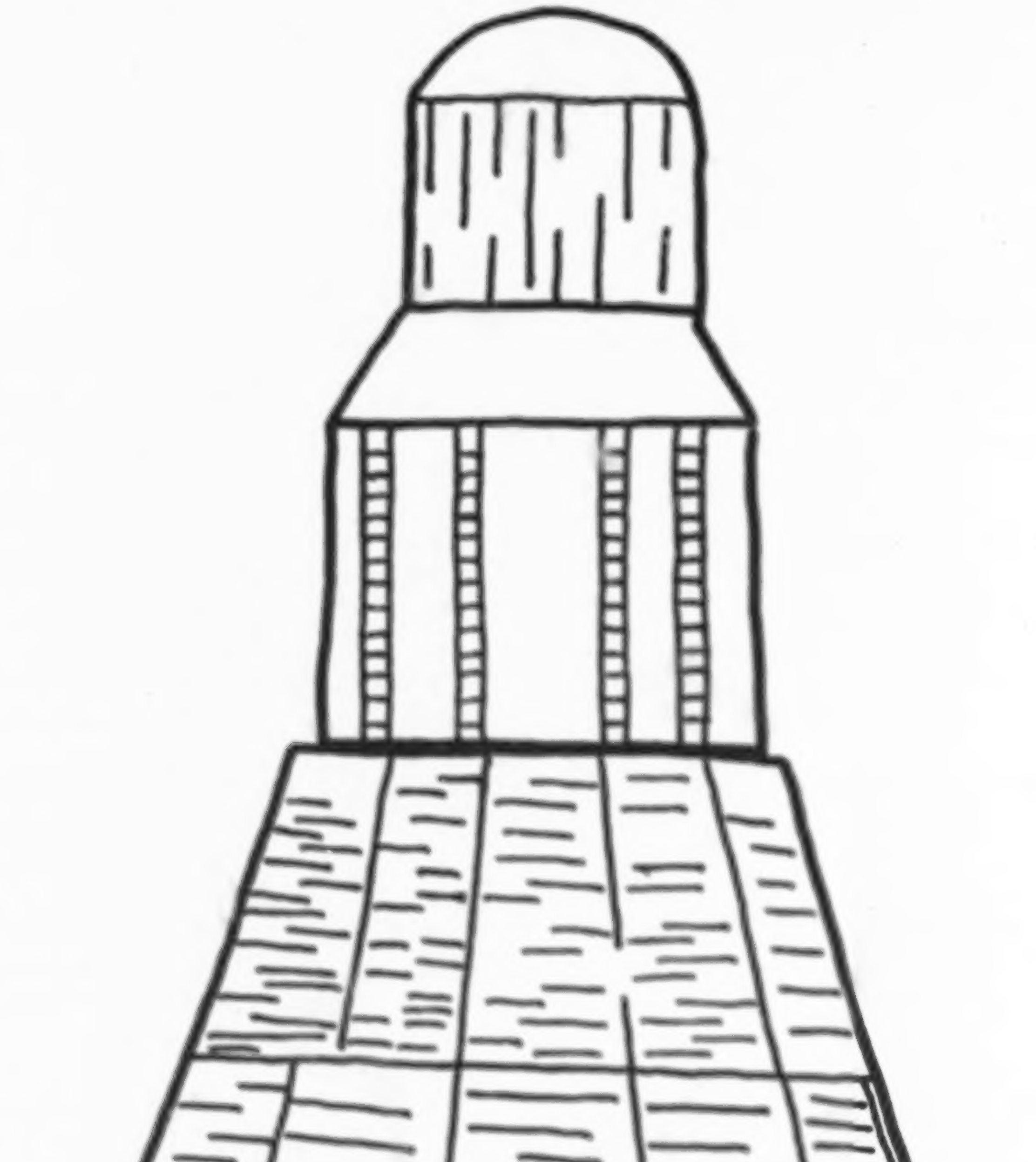
- Mercury Capsule
  - Project Mercury --Suborbital Flight
  - Project Mercury--Orbital Flight

- Project Gemini Capsule
  - Project Gemini--Docking

- Project Apollo--Spacecraft
  - Project Apollo--Lunar Landing
  - Project Apollo--Return to Earth

Models

Mercury Space Capsule
Gemini Space Capsule
    Revell, Incorporated
    Venice, California



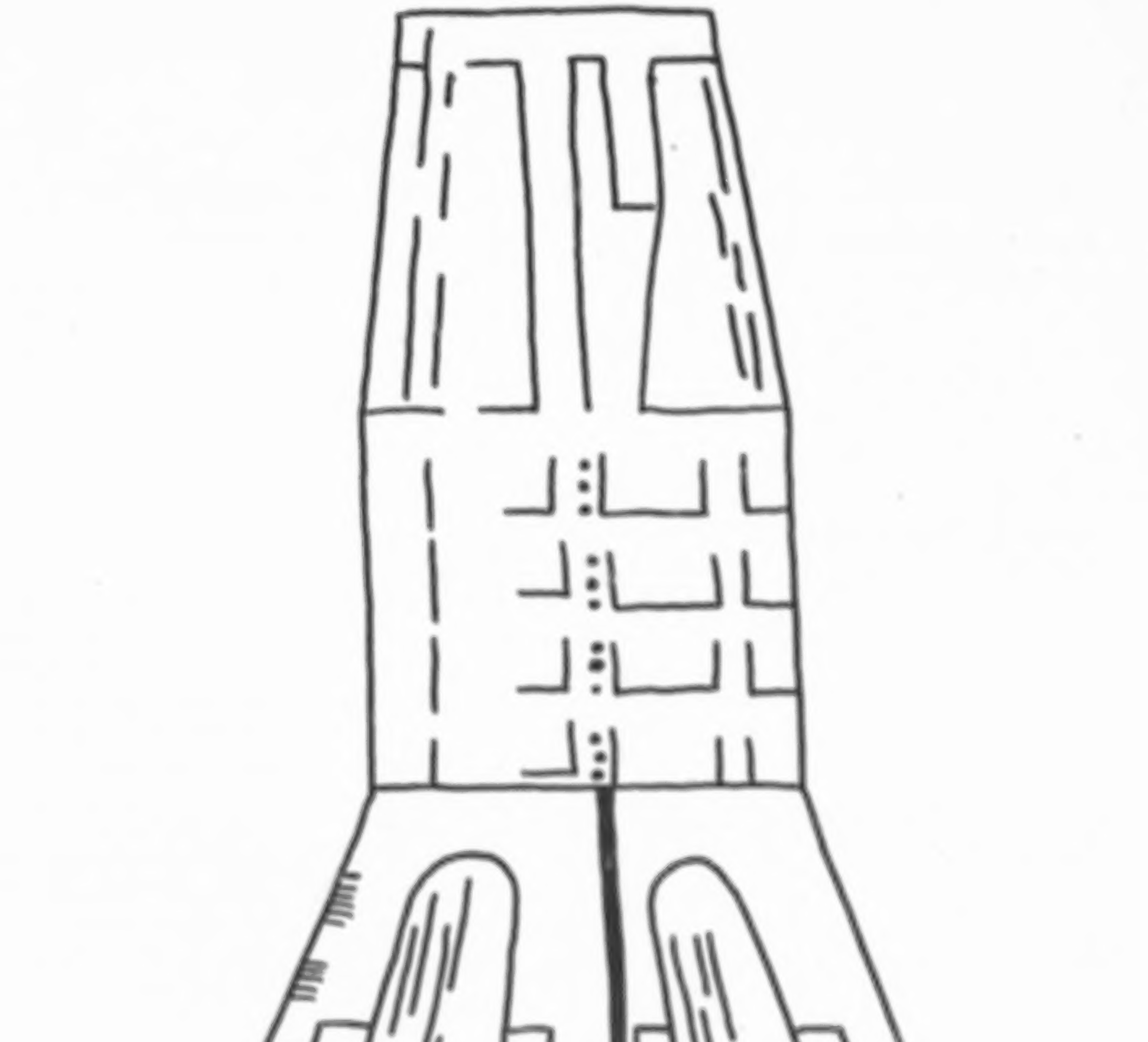
MERCURY CAPSULE

Figure 1

TABLE III

UNITED STATES MERCURY ASTRONAUTS AND HIGHLIGHTS OF MERCURY FLIGHTS

PROJECT MERCURY	DATE	REVOLUTIONS	SPACECRAFT NAME	ACCOMPLISHMENTS
Alan B. Shepard, Jr.	5-6-61	Sub-orbital	Freedom 7	America's first manned suborbital space flight
Virgil I. Grissom	7-21-61	Sub-orbital	Liberty Bell 7	Evaluated spacecraft functions
John H. Glenn	2-2-62	3	Friendship 7	America's first manned orbital flight
M. Scott Carpenter	5-24-62	3	Aurora 7	Initiated experiments to further future space efforts
Walter M. Schirra,Jr.	10-3-62	6	Sigma 7	Developed techniques and procedures applicable to long missions in space
L.Gordon Cooper,Jr.	5-15 to 5-16-63	22	Faith 7	Met final objective of Mercury program by spending one day in space



GEMINI CAPSULE

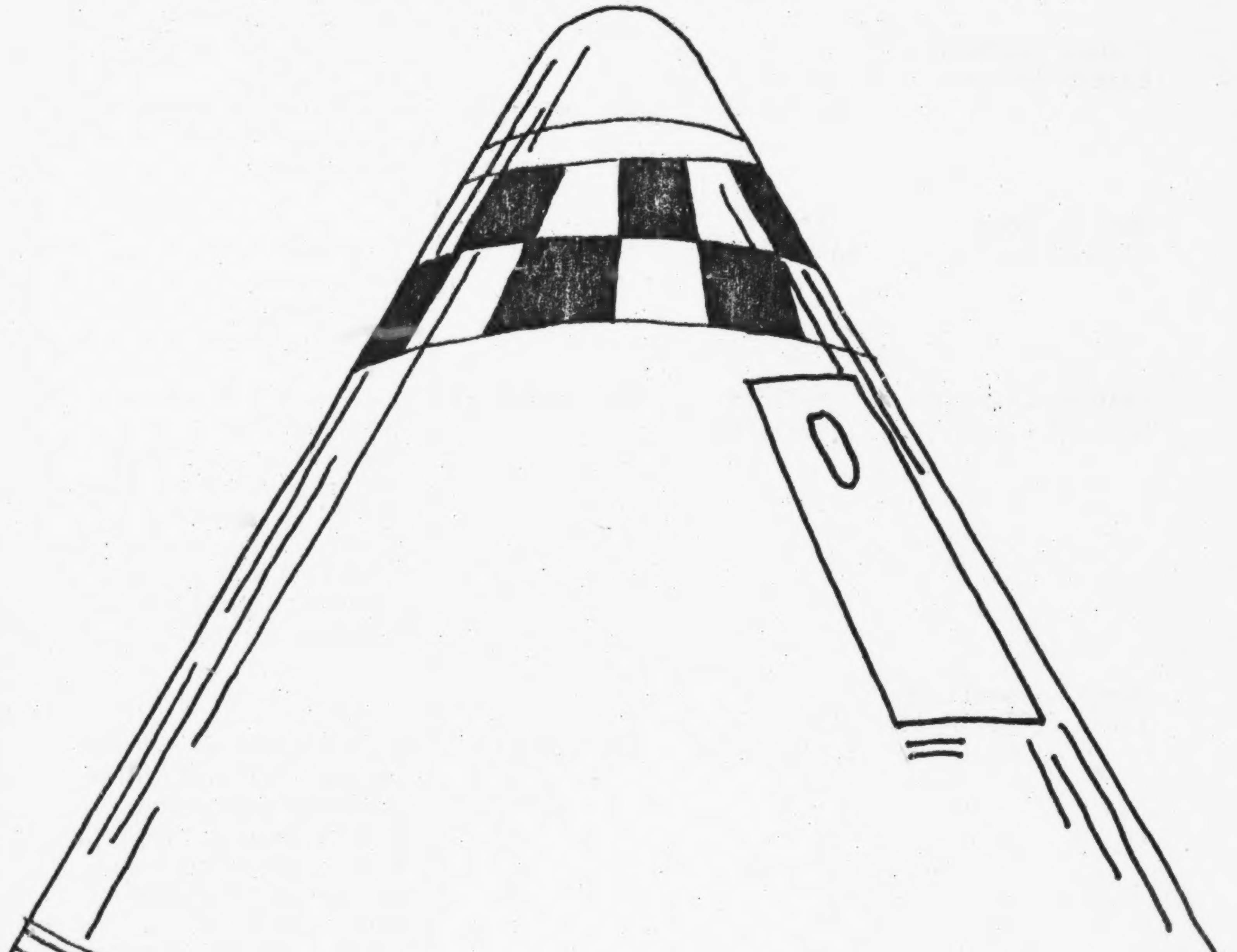
Figure 2

TABLE IV

UNITED STATES GEMINI ASTRONAUTS AND HIGHLIGHTS OF GEMINI FLIGHTS

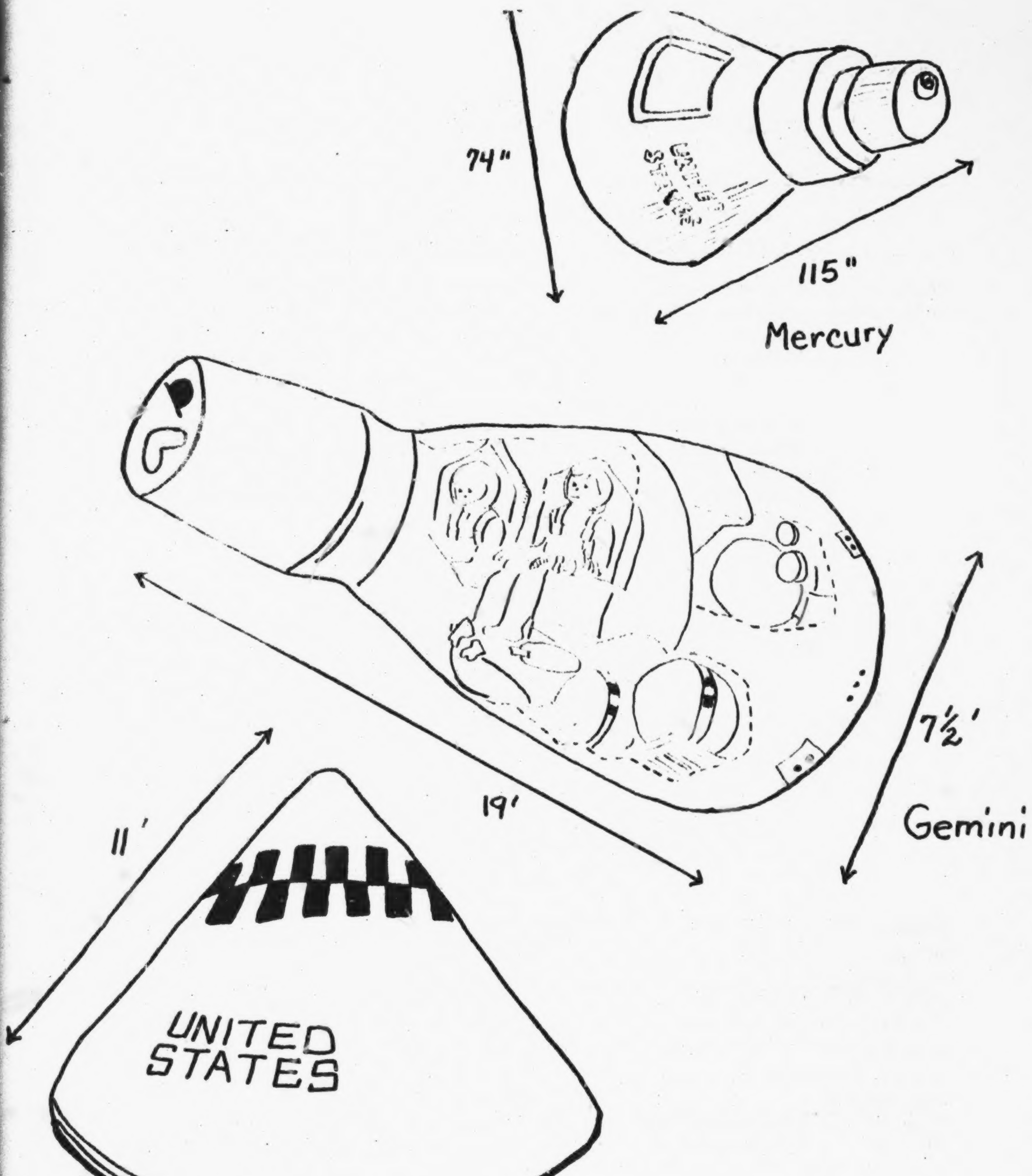
PROJECT GEMINI	DATE	REVOLUTIONS	SPACECRAFT NAME	ACCOMPLISHMENTS
Virgil I. Grissom John W. Young	3-23-65	3	Gemini 3	First U. S. two-man crew; first crew use of orbital maneuvering system; first control of reentry flight path using spacecraft lift.
James A. McDivitt Edward H. White	6-3-65 to 6-7-65	65	Gemini 4	First U. S. extra-vehicular activities; first use of personal propulsion unit; 11 scientific experiments carried out.
L. Gordon Cooper, Jr. Charles Conrad, Jr.	8-21-65 to 8-29-65	127	Gemini 5	Demonstrated physiological feasibility of lunar mission; successful simulated rendezvous; first use of fuel cell.
Frank Borman James A. Lovell, Jr.	12-4-65 to 12-18	220	Gemini 7	World's longest manned orbital flight; extensive testing of physiological factors and spacecraft performance; target for first rendezvous with Gemini VI.
Walter M. Schirra, Thomas P. Stafford	12-15-65 to 12-16-65	17	Gemini 6	World's first successful space rendezvous with Gemini 7.

PROJECT GEMINI	DATE	REVOLUTIONS	NAME	ACCOMPLISHMENTS
Neil Armstrong David Scott	3-16-66	7	Gemini 8	First dual launch and docking with Agena; mission curtailed by a short circuit in orbital attitude maneuvering system. First Pacific landing.
Thomas Stafford Eugene Cernan	6-3-66 to 6-6-66	48	Gemini 9	Two hours and two minutes of extravehicular activity accomplished.
John W. Young Michael Collins	7-18-66 to 7-21-66	44	Gemini 10	First dual rendezvous; first docked vehicle maneuvers; micrometeoroid equipment retrieved from GTV-8.
Charles Conrad,Jr. Richard F. Gordon	9-12-66 to 9-15-66	44	Gemini 11	Rendezvous and docking achieved within first revolution; two hours and 55 minutes of extravehicular activity by Gordon. Highest apogee (739 nautical miles); computer controlled reentry.
James A.Lovell,Jr. Edwin E.Aldrin,Jr.	11-11-66 to 11-15-66	59	Gemini 12	Final mission of Gemini series. Extravehicular activity evaluation: Aldrin took a 2 hr., 9 min. space walk and performed simulated repair work on the spacecraft. He maneuvered with ease in his 3 outside excursions that totaled 5 hrs. & 37 min. 14 experiments performed Solar eclipse pictures taken.



APOLLO CAPSULE

Figure 3


74"
115"
Mercury
19'
7½'
Gemini
11'
UNITED STATES
Apollo
13'

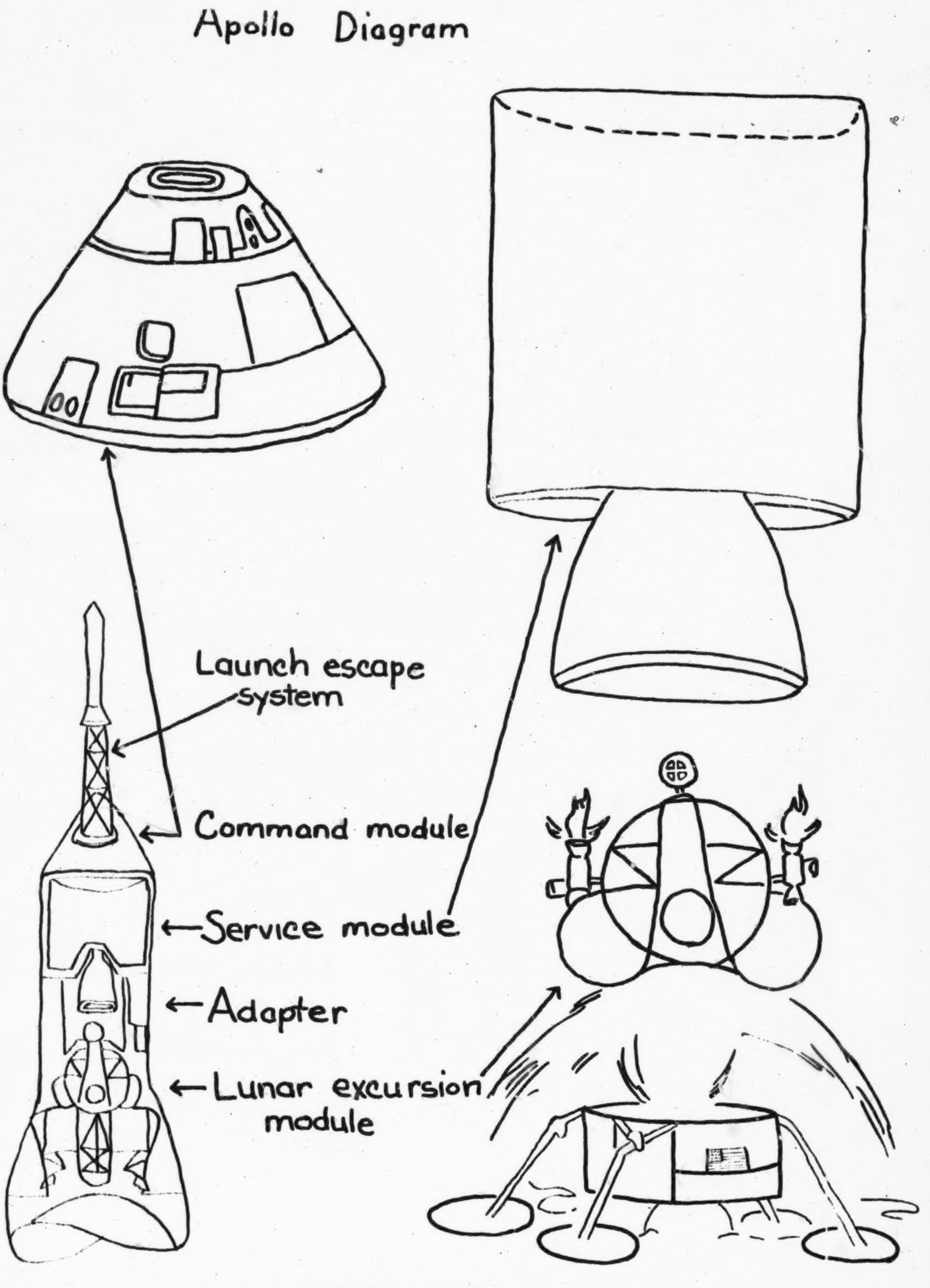
COMPARISON OF MERCURY, GEMINI AND APOLLO CAPSULES

Figure 4

TABLE V

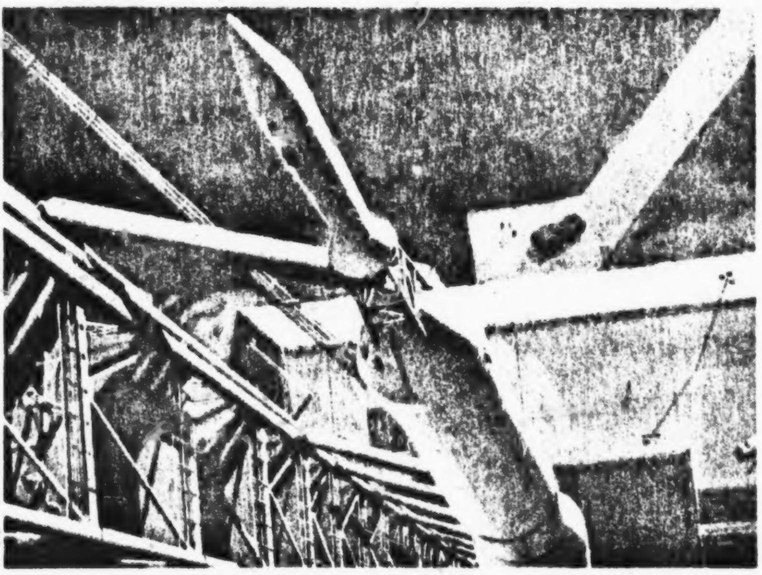
COMPARISON OF MERCURY, GEMINI AND APOLLO PROJECTS

	MERCURY (one man capsule)	GEMINI (two man capsule)	APOLLO (three man capsule)
Project objectives	To investigate man's ability to survive and perform in the space environment. To develop the basic space technology and hardware for future manned space flight programs.	To subject two men and supporting equipment to long flights. To effect rendezvous and docking with another orbiting vehicle. To leave spacecraft while in orbit and determine ability to perform extravehicular activities. To perfect methods of reentry and landing of spacecraft at a preselected landing area.	To land two men on the moon who are to make a limited exploration of landing area. To return astronauts and their lunar samples and photographs to earth.
Number of manned missions	6	10	
Length of flights	15 min. to 34 1/3 hrs.	4 hrs. 53 min. to 94 hrs. 35 min.	
Size and weight of spacecraft	9½ x 6 ft. 3000 lbs. approx.	reentry module 11 x 7.5 ft 7000 lbs.	Command module 11 x 13, 5 tons
Type of flight	Sub-orbital and earth orbital	Earth orbital	Earth orbital, lunar orbital, and moon landing

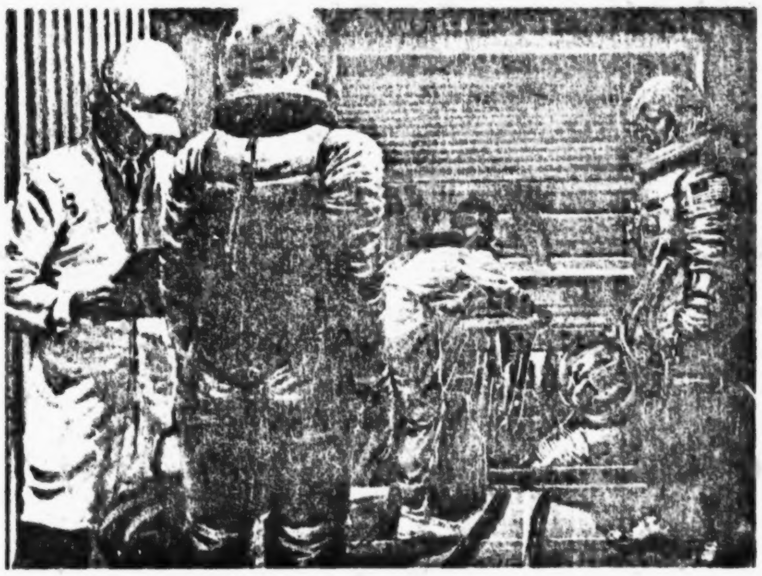

Apollo Diagram
Launch escape system
Command module
Service module
Adapter
Lunar excursion module

APOLLO DIAGRAM

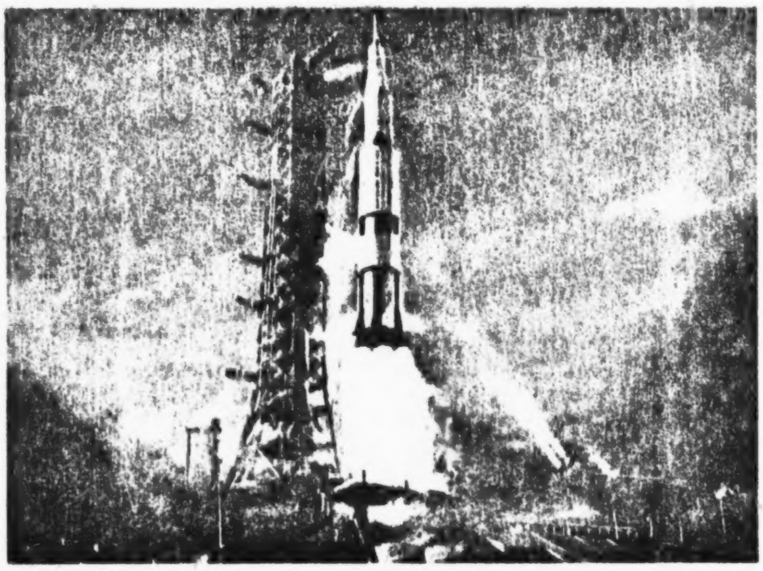
Figure 5



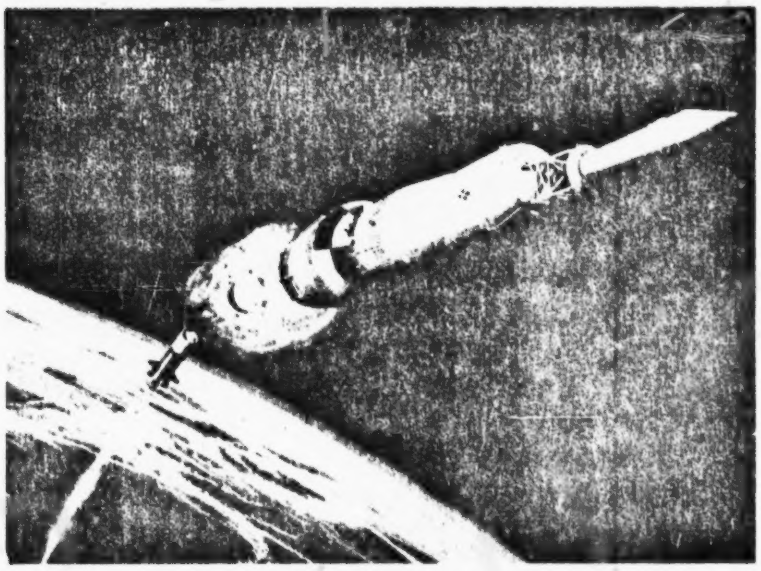
Giant booster undergoes last-minute checks before launch



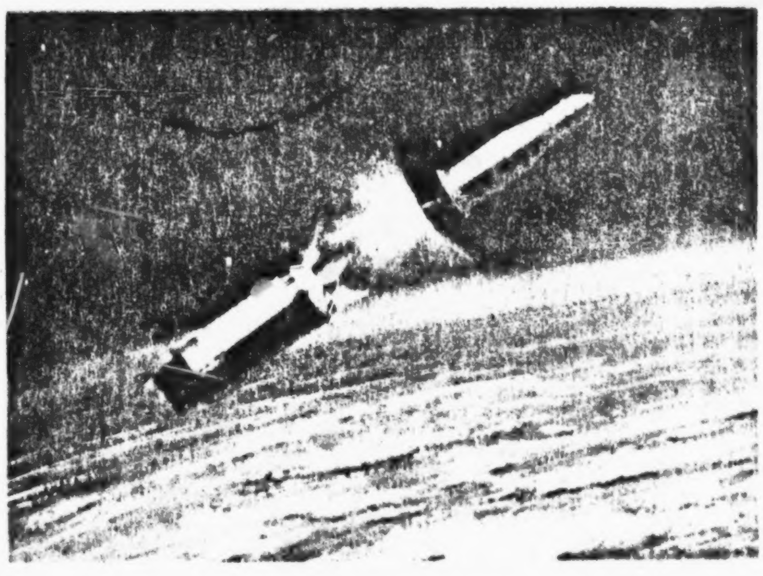
Astronauts enter CM from service tower after final checks



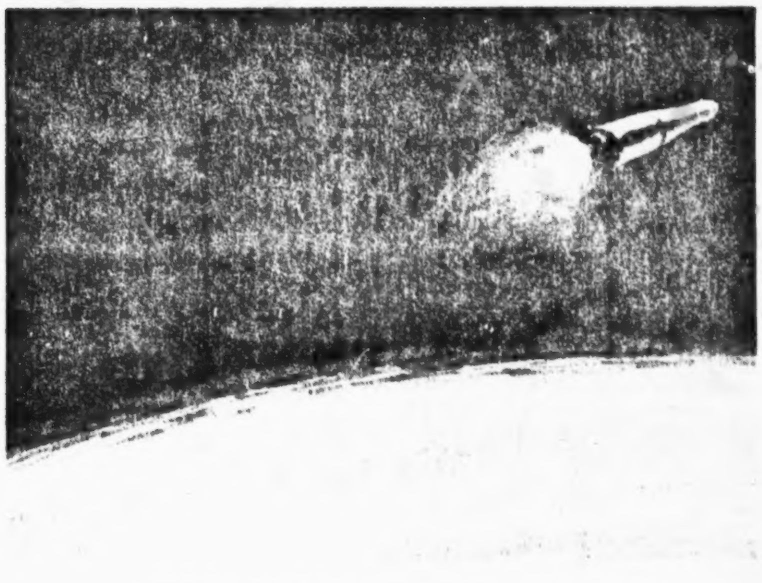
Saturn V lifts Apollo spacecraft off pad at Cape Kennedy



Saturn V second stage ignites as the first stage falls away



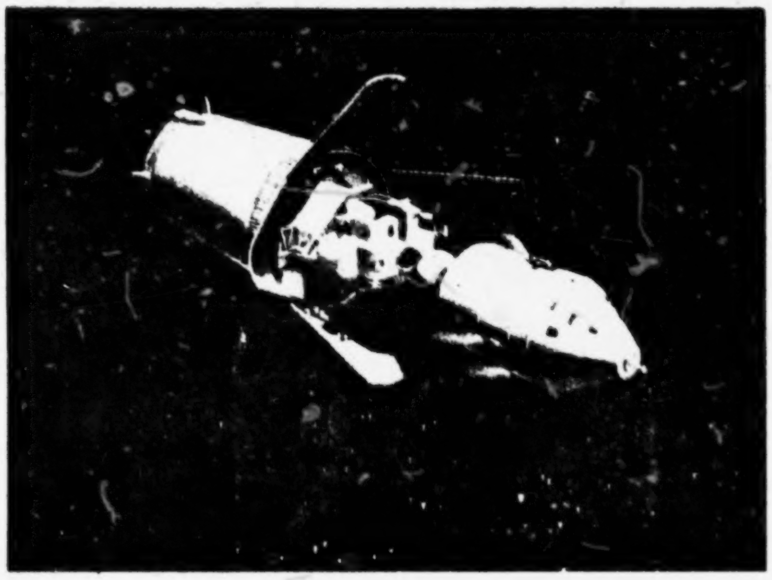
Second stage is jettisoned and third stage is ignited



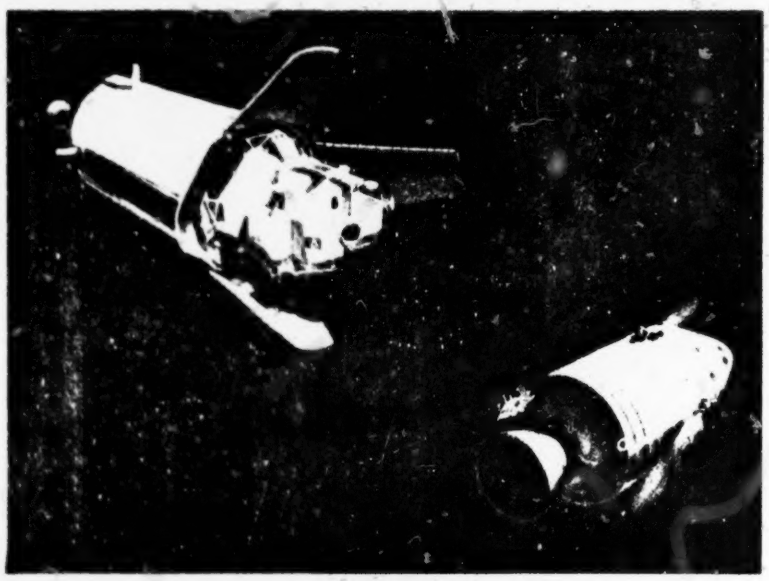
Third stage pushes spacecraft out of earth's orbit

PROJECT APOLLO: EARTH ORBITAL PHASE

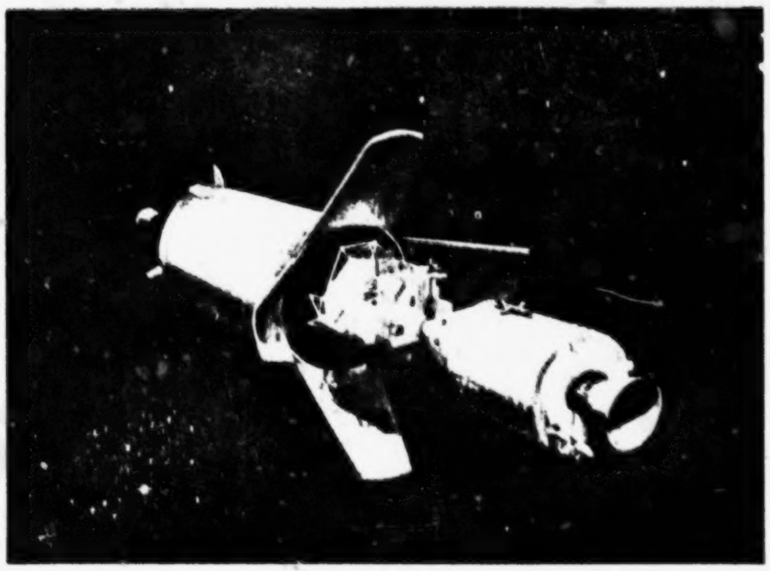
Figure 6



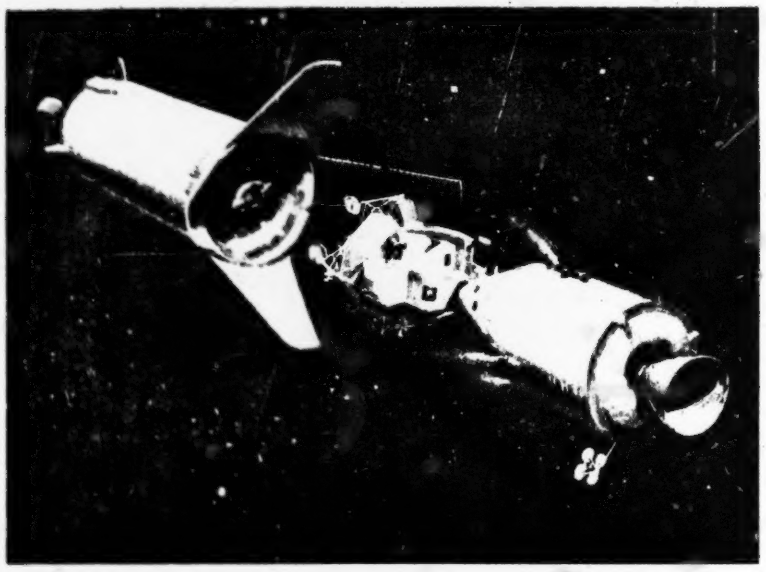
Adapter panels are opened and CSM separates



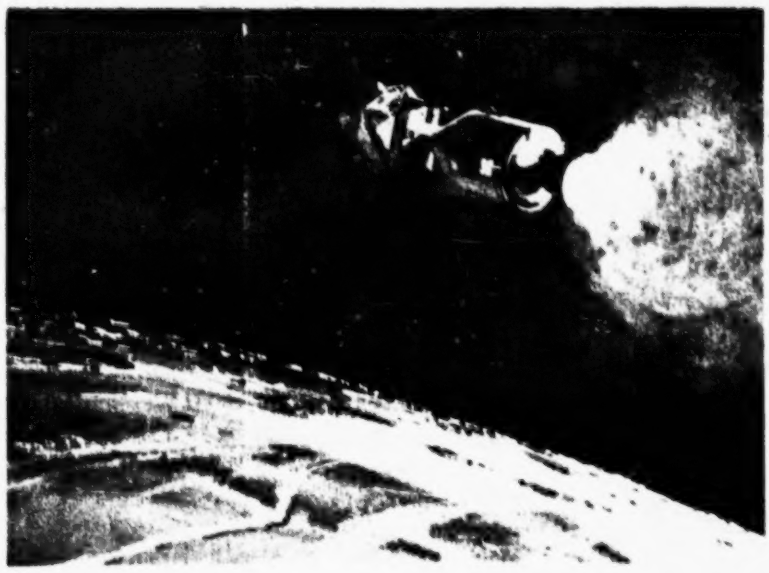
CSM turns around to get into position for docking



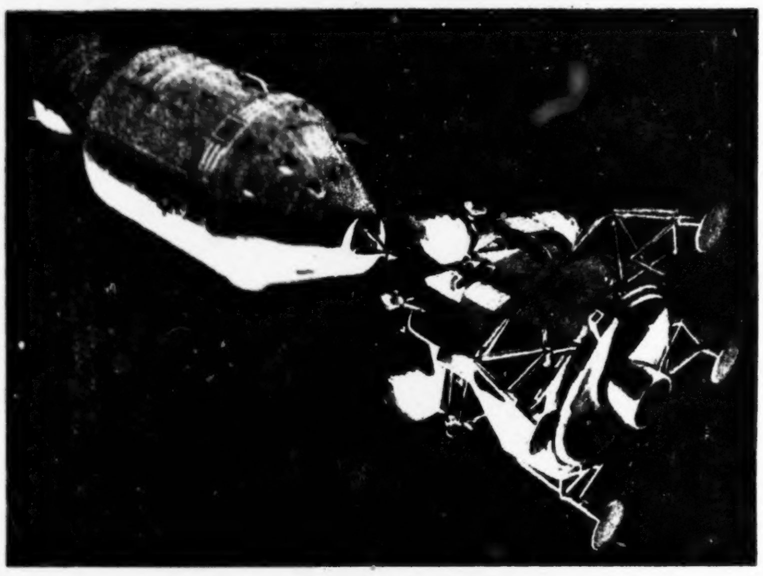
Command module docks with LM



After docking, spacecraft leaves third stage behind



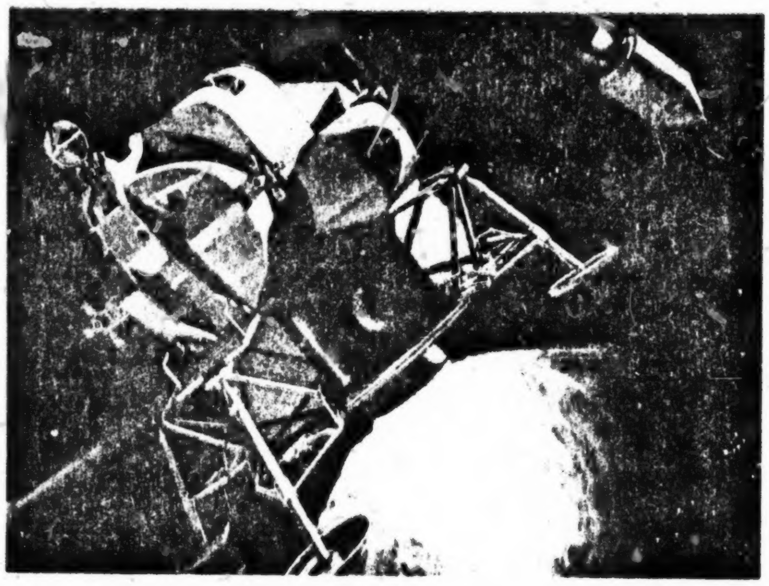
SM engine fires to put spacecraft in orbit around moon



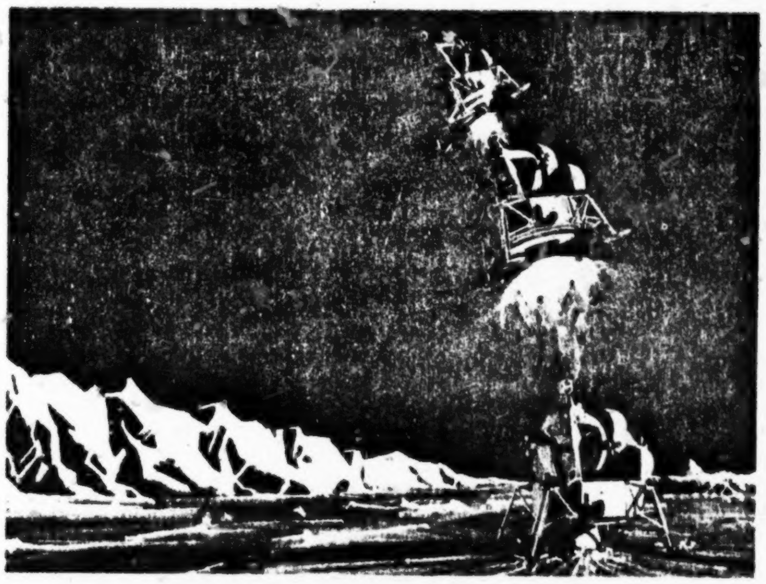
LM separates from CSM to begin descent to moon

PROJECT APOLLO: CM-LM REALIGNMENT

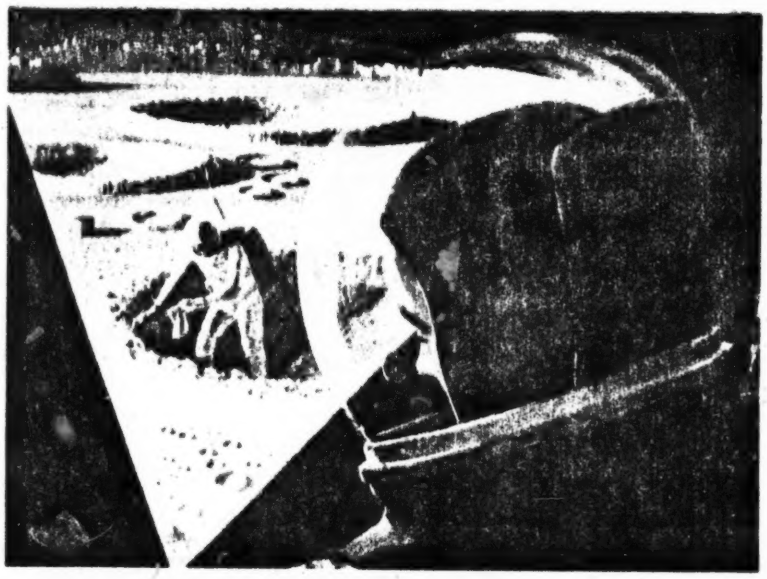
Figure 7



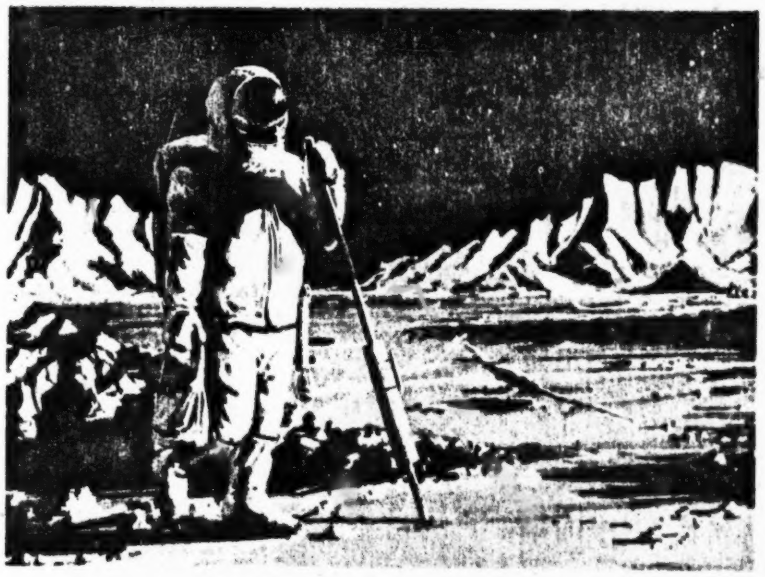
LM engine fires while CSM remains in orbit



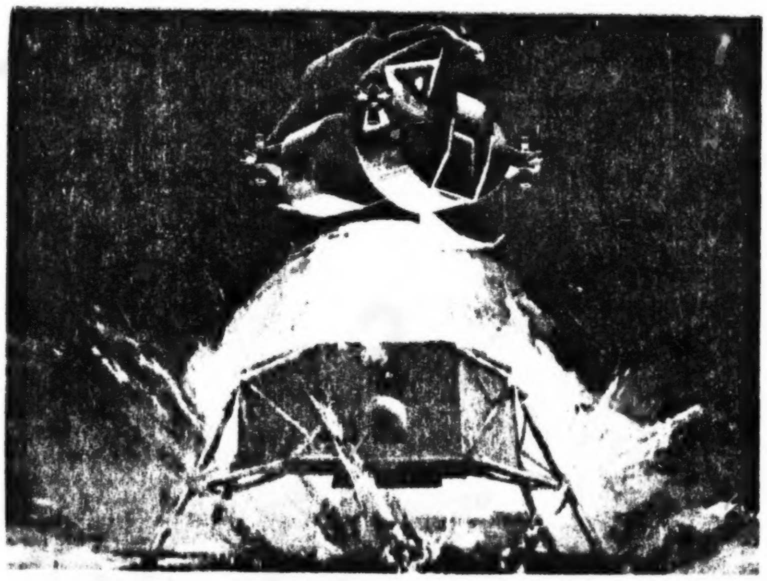
Two astronauts guide LM to landing on lunar surface



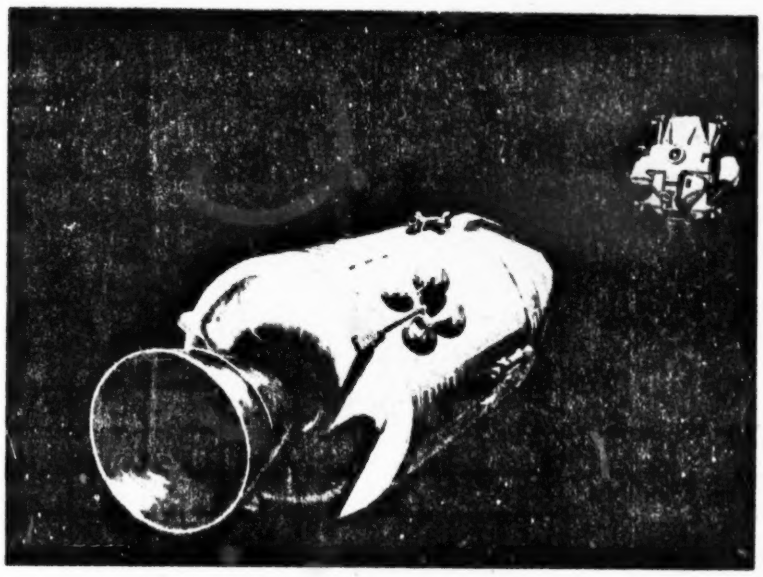
Astronaut gathers soil samples from the lunar surface



Astronaut explores surface of moon



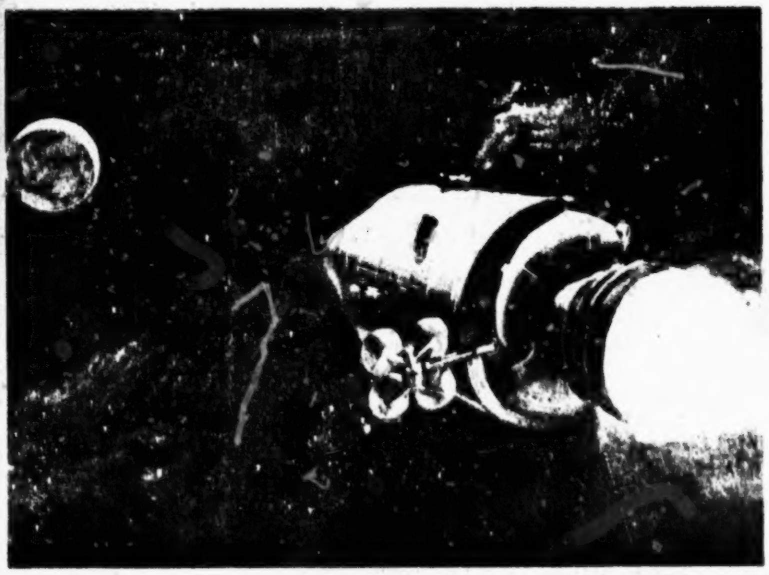
Engine fires to lift LM ascent stage off moon and into orbit



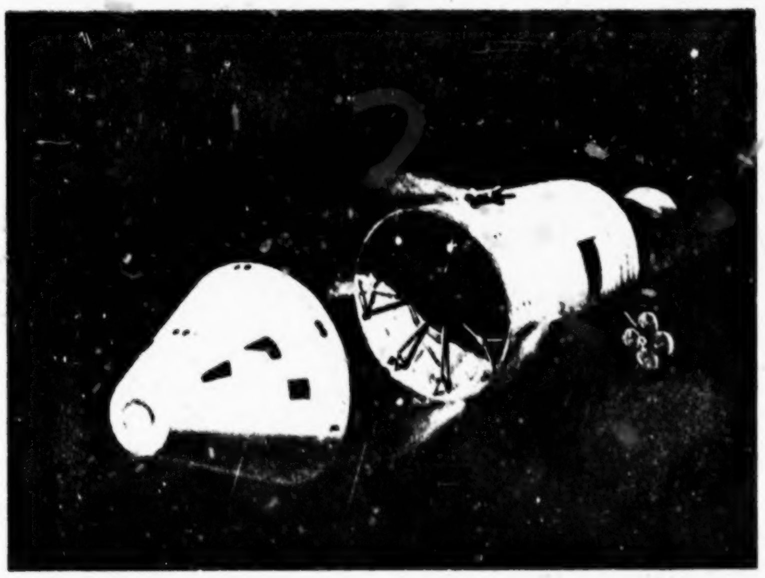
Astronauts in LM line up their craft for docking with SC CSM

PROJECT APOLLO: LUNAR EXPLORATION PHASE

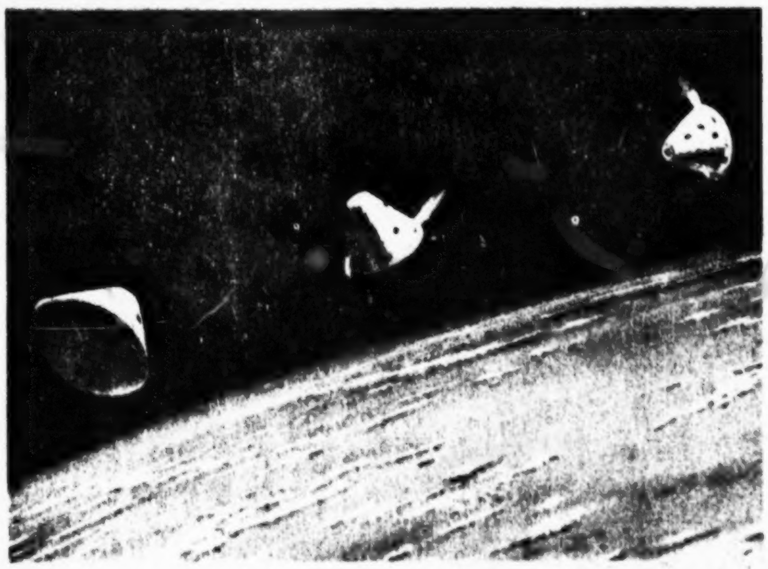
Figure 8



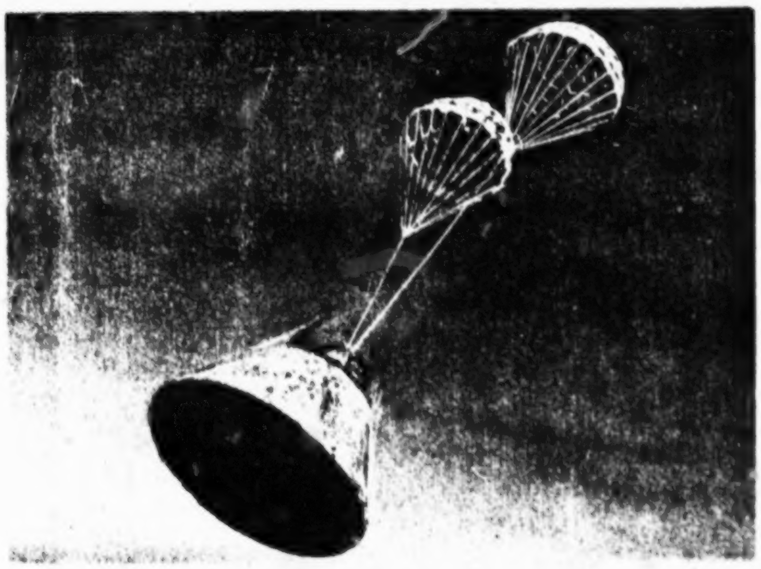
SM engine fires to start homeward journey; LM stays behind



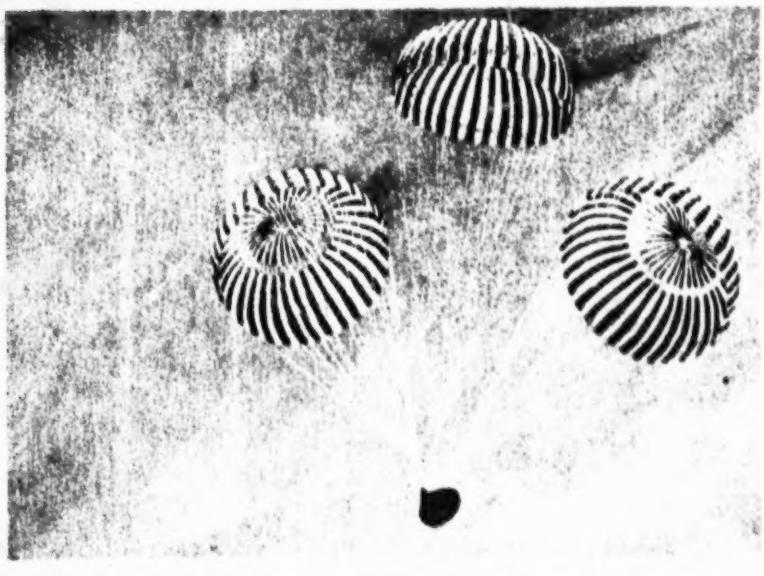
SM is jettisoned as CM prepares for entry into atmosphere



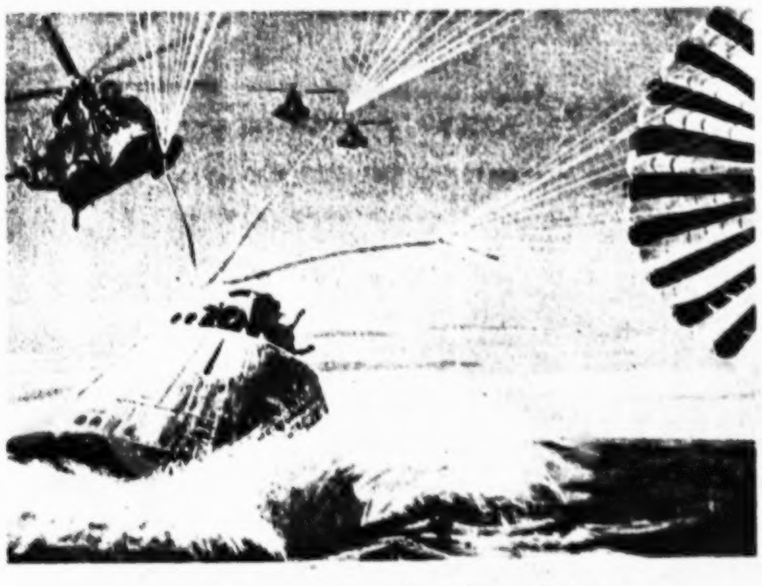
Pilot orients CM so base heat shield takes friction heat



Drogue parachutes are deployed for initial slowing of CM



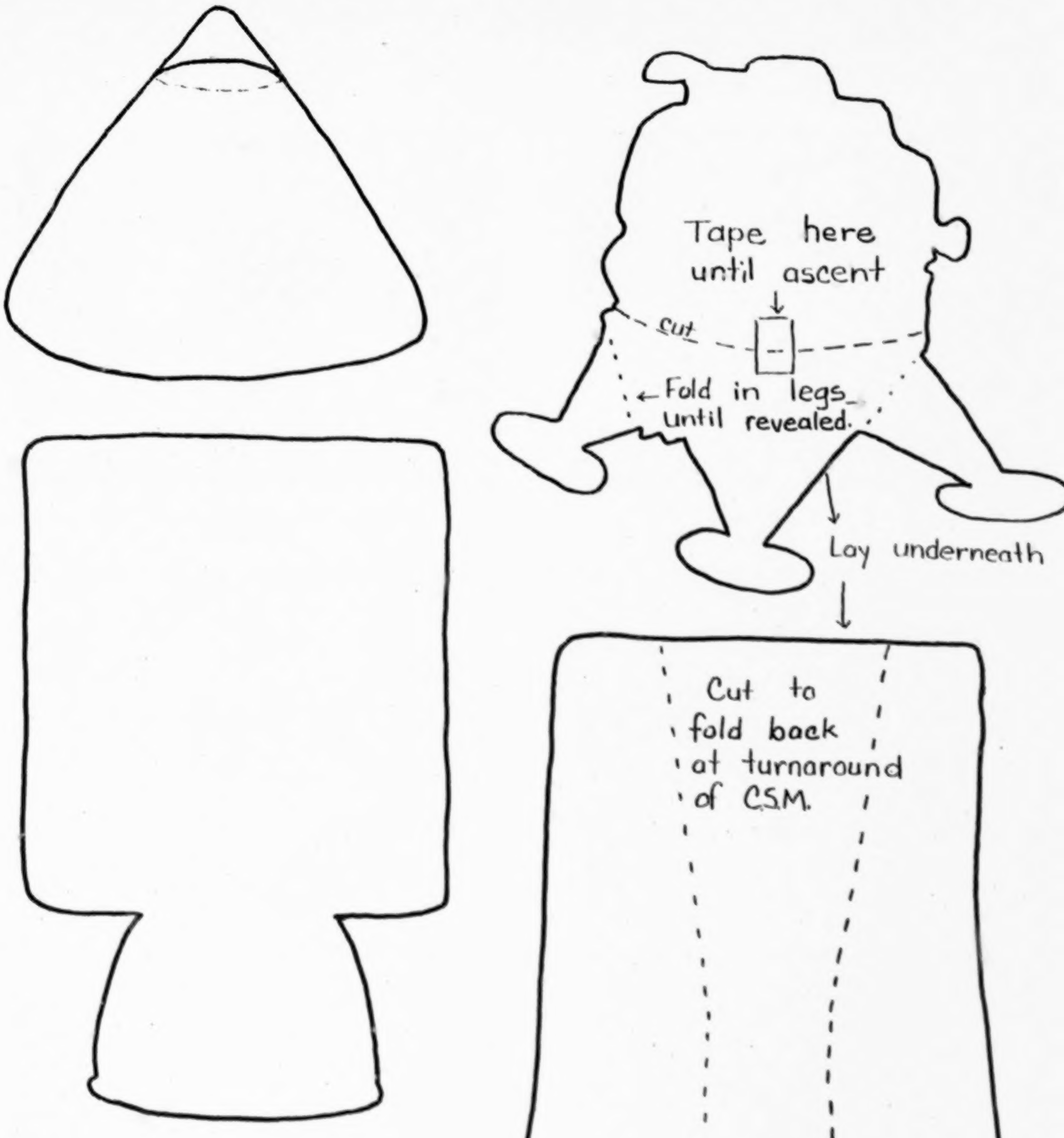
Main parachutes are deployed to lower CM safely to surface



Recovery forces move in as the CM floats in water

PROJECT APOLLO: RETURN TO EARTH

Figure 9


Tape here
until ascent
cut
Fold in legs
until revealed.
Lay underneath
Cut to
fold back
at turnaround
of C.S.M.

APOLLO CUTOUT

Figure 10

WHAT SHALL I WEAR?

Topic

Space suits

Background

One of the most important phases of the manned space flight effort has been designing clothing to protect astronauts from the hazards that they will encounter in space. Designing a spacesuit is an extremely complex task because the suit must provide a pressurized atmosphere around the wearer, but it still must allow him freedom of movement and relative comfort while he is wearing it. The suits worn by NASA astronauts on the manned space flights are custom tailored to the astronaut and the mission to which he has been assigned.

The early space suits were very uncomfortable. When they were pressurized it was almost impossible for the men wearing them to move, but by the time Gemini astronauts donned "hard suits" (pressurized suits), a practical garment had been developed.

The Gemini crews wore suits made from a rubberized-nylon fabric with an aluminum coating. Ventilation was provided by an air conditioning system from within the spacecraft. A helmet, tight fitting gloves and special boots were also worn. On space walks a slightly different suit was used. It had an extra layer of nylon and aluminized mylar to protect the astronaut from the temperature extremes and micrometeroids in space. The helmet worn outside the capsule had two external visors. The inner visor, primarily used for protection against micrometeroids, was made from plastic thirty times stronger than the material used for aircraft canopies. The outer layer was tinted to protect the astronaut's eyes from glare. An umbilical cord connected the astronaut and his protective suit to the spacecraft life support systems.

The Apollo crewmen will have a changeable wardrobe. On the trip, two of the men (in rotation with the third) will relax in their "constant wear garment," a two-piece close-fitting paper garment which covers all of the body except the head and hands. The third man will be in the Apollo space suit which has "accordian joints," for flexibility and ease in walking, bending, or moving. A special space suit will be worn by the two astronauts who explore the moon. It will consist of the basic Apollo suit with several additional layers. Underneath the pressure suit will be a special garment interwoven with a fine network of water-circulating tubes to carry away body heat. Covering the entire space suit will be a "thermal meteroid garment" worn to protect the astronaut from the blistering sunshine and from micrometeroid dust which may rain down on the moon at a high speed. An important unit of the Apollo space suit system is the strap-on backpack for lunar exploration. The pack contains a four-hour oxygen supply, two-way radio, heat dumping radiator, and dosimeter (radiation gauge).

The Apollo space suits are pictured and described in Figure 11.

Vocabulary

accordion-joints
astronauts
breathing tube
dosimeter
flexible
hard suit
helmet
meteoroid cape
mylar
nylon
oxygen
pivoted
pressure
protection
radiation
soft-suit
thermal garment
torso

Suggested Activities

a. Children could make an astronaut puppet, and using paper, tinfoil, saran wrap, etc. could construct a space suit for it.

b. Children can make helmets from plastic bottles, papier mache, sacks, etc.

c. To demonstrate the problems involved in designing space suits have a child wear a pair of over-sized mittens that are stuffed with cotton. Ask him to attempt the following tasks:
   1. Place a nut on a bolt and tighten it with a wrench.
   2. Remove a screw from a board with a small screwdriver.
   3. Blow his nose with his handkerchief.
   4. Turn the knobs on a radio, door, TV or other appliance.
   5. Turn pages of book and write on paper.

   Dress a child in four or five large shirts and in three or four pairs of trousers. Place two or three belts around the child's abdomen to simulate the restrictiveness of space suit. Have the child perform the following activities: (don't prolong them)
   1. Bend down to touch his toes.
   2. Attempt to catch a ball thrown by his classmates.
   3. Lie down to prepare for sleep.
   4. Climb up and down the stairs.

Source Materials

Books

Gurney, Gene., Americans Into Orbit, New York: Random House, 1962 i.

Kay, Terrance, Space Volunteers, New York: Harper and Brothers, 1960 i.

Priestley, Lee, Rocket Mouse, New York: Abelard Schuman, 1961 p. i.

Shelton, William Ray, Flights of the Astronauts, Boston: Little, Brown and Co., 1963 t.

NASA Facts - NF - 23/vol. IV, #7, National Aeronautics and Space Administration, Supt. of Documents, U. S. Government Printing Office, Washington, D. C., or address Regional NASA Center; for Nebraska=Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058

Films

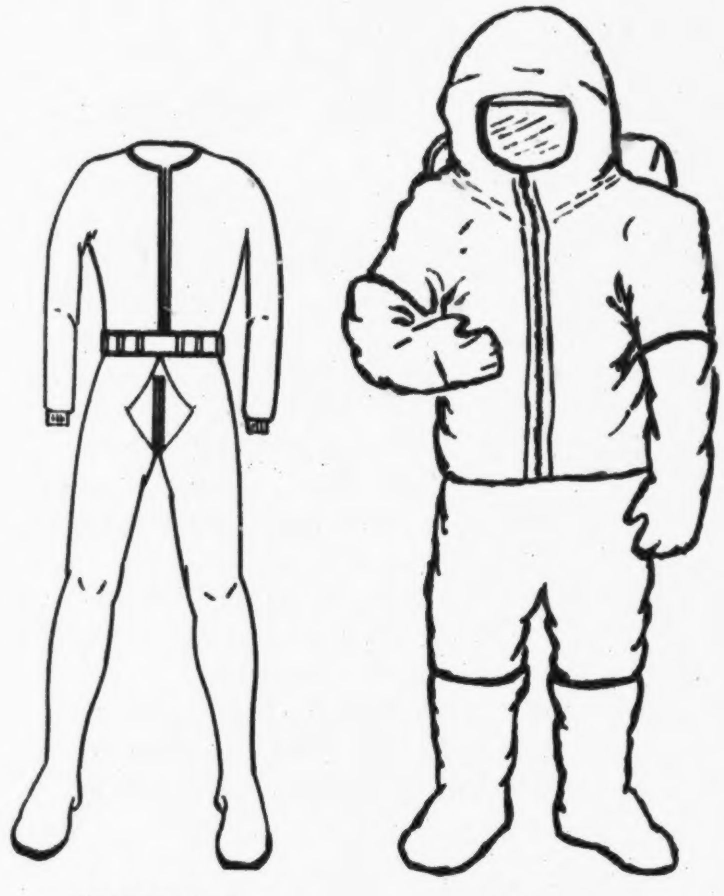
A Space Flight Around the Earth, 12 min., color, Churchill Films i.

Filmstrips

The New Frontiers in Space
Project Apollo, Filmstrip of the Month Club
The Space Age, color, Eye Gate House i.
Tommy Looks at Space, #603, color, 20 min., Free loan NASA
National Aeronautics and Space Administration, Educational Programs and Servies, Washington, D. C. or address Regional NASA Center; for Nebraska - Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058

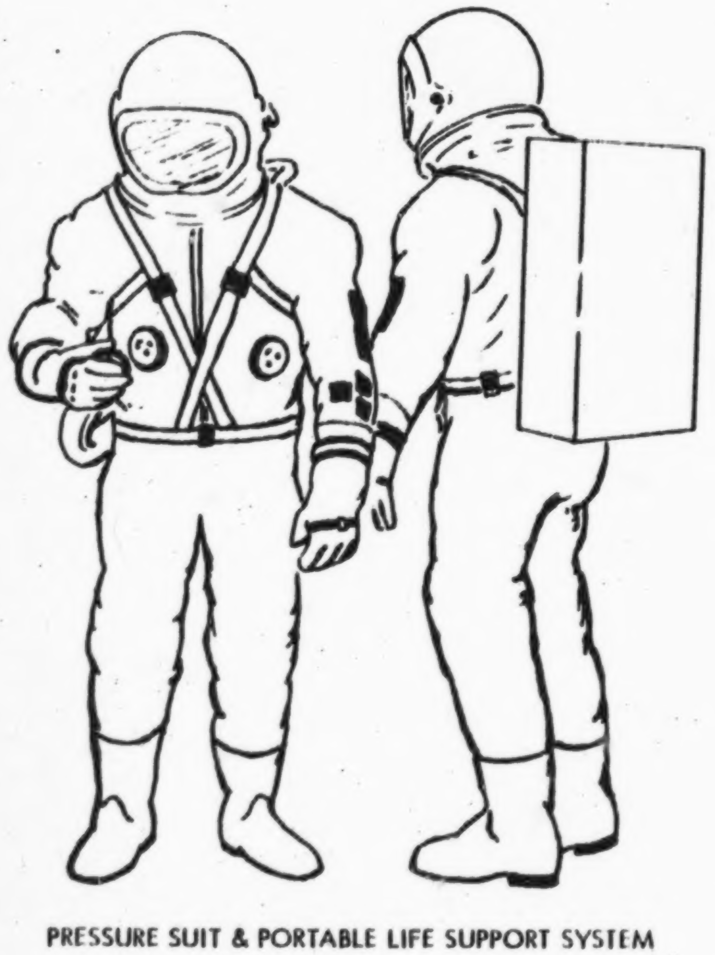
Space Explorer Puppet Playmates (child-sized cutouts of two spacemen, robot, and a man from outer space) #1104 $4.95
Instructo Company
School Specialty Supply
212-14-16 South Santa Fe
Saline, Kansas 67401

CLOTHING FOR VARIOUS PHASES OF PROJECT APOLLO



CONSTANT
WEAR GARMENT

THERMAL
METEOROID GARMENT



PRESSURE SUIT & PORTABLE LIFE SUPPORT SYSTEM

Constant-Wear Garment—This is a two-piece, close-fitting garment which covers the entire body except the hands and head. It will be worn at all times during the mission (including under the space suit), and is the basic garment for shirtsleeve operations.

Communication Helmet—Consists of a cloth and plastic helmet for protection of the head, with two microphones and two earphones attached to it.

Restraint Sandals—These are worn over the feet of the constant-wear garment, and have soles made of Velcro pile material which adheres to the Velcro hook material installed on the CM floor (aft bulkhead).

APOLLO GARMENTS

Figure 11

ON YOUR MARK. . .GET SET. . .GO!

Topic

Final launch preparation (astronaut and capsule)

Background

The countdown immediately before a big space vehicle is launched has become a familiar and very exciting occurrence, but this familiar portion of the count measures only the last 10 seconds before a launch. The "pre-count" actually started as much as three days before the blastoff.

Preparations for the blastoff of a giant Atlas, Gemini (Titan II), or Saturn launch vehicle are very exacting and take a great deal of time. Every system, component and part in the vehicle must be checked thoroughly and declared ready. If even one tiny bolt isn't in place the countdown is stopped until the problem is corrected. The last few days and hours on the launch pad include a busy, constant schedule of final checks. This entire period of time is called the "countdown."

The launching of a manned space capsule requires that both the astronaut and the launch vehicle be in perfect condition. On the day of the flight the crew members are given a final medical examination and before putting on the space suits, biological sensors are attached to their bodies. After the examination of the astronauts has been completed the final check of the launch vehicle and capsule take place, and the astronauts enter the capsule.

About an hour before launch, loud horns warn people to vacate the gantry. At approximately T (launch time) minus thirty-five seconds, the umbilical cord connecting the launch vehicle with service systems on the ground is dropped. If the signal from every system is "Go," the astronauts are on their way.

All times before launch are called "minus time," and the time after launch is refered to as "plus time." Thus, "T minus 2 minutes" means that two minutes remain before launch; "T plus 9 seconds" means that launch occurred 9 seconds earlier. The minus countdown ends with "T-time," when rocket engine ignition and lift-off occur. After T-time, the countdown continues into the plus count.

Vocabulary

biological sensors
countdown
gantry

hatch
launch
pressure suit

T-time
umbilical cord

Suggested Activities

a. Plan a pre-launch time line. Begin with the building of a launch vehicle.

b. The children could write a story telling how they would feel during the countdown if they were astronauts.

c. Make a space capsule large enough for children to get into.

d. Listen to recordings of real launches or let the children make a tape recording of an imaginary launch.

Source Material

Books

The Astronauts Themselves, We Seven, New York: Simon and Schuster, 1962 t.
Colby, C. B., Countdown, New York: Coward-McCann, Inc., 1960 i. t.
Coombs, Charles, Lift-off, New York: William Morrow & Co., 1963 i.
Faget, Max, Manned Space Flight, New York: Holt, Rinehart and Winston, Inc., 1965 t.
NASA Facts, The Countdown, National Aeronautics and Space Administration, Supt. of Documents, U. S. Government Printing Office, Washington, D. C. or address Regional NASA Center; for Nebraska Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058

Films

The Birth of a Spacecraft, 14 min., color, McDonnell Aircraft Corp., P. O. Box 516, St. Louis, Mo., W. C. Bunch, Supervisor Cinematography and Exhibits

MR-1 Launch (MSC-60-091) 14 min. NASA
MR-1 Launch (MSC-61-094) 14 min., NASA
Prelude to Orbit (MSC-61-111) 26 min. NASA
National Aeronautics and Space Administration, Educational Programs and Services, Washington, D. C. or address Regional NASA Center; for Nebraska - Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058

Record

Journey to the Moon, L. P. 158, Golden Records

Tapes

Discovering Through Space Series

A Trip to the Planets
Our Satellite the Moon
Taking a Closer Look at the Stars
Our Nearest Star, the Sun

Imperial Instructional Tapes, School Specialty Supply,
P. R. Box 1363, Salina, Kansas 67401

SPEAKING THROUGH SPACE

Topic

Communication with an astronaut

Background

For manned space flight, it is vitally important to be able to communicate with the spacecraft crew The earth-spacecraft communications must take place in "real time," that is, at the time it is happening, not hours afterward. To maintain communications, stations located all around the world follow a manned satellite on its journey.

These stations are part of NASCOM (NASA Communications Network), a worldwide communications system. From the hub of activity at Goddard Space Flight Center, NASCOM provides high-speed ground communications support for manned, unmanned, and deep space missions. It links eighty-nine stations, including thirty-four overseas points, with teletype, voice, and data communications. Its circuits and terminals span 100,000 route miles and 500,000 circuit miles. NASCOM uses commercial and government land-line circuits, ocean cable, radio, and communications satellites, and includes sub-switching centers in London, Honolulu, and Canberra, Australia. The heart of this system is a communications processor which uses a digital computer for receiving, examining, storing, cueing, and transmitting messages electronically at very high speeds.

The communications and tracking network for the Mercury and Gemini Programs consisted of seven primary land sites, and two ships. Locations of the primary land stations are: Florida; Bermuda; Grand Canary Island; Australia; Hawaii; Mexico and Texas.

The Deep Space Network supports NASA's lunar and planetary missions. This system uses extremely powerful and very sensitive antennas to receive data from spacecraft, determine their location in space and command them to maneuver in space. Deep Space Network stations are located 120° of longitude apart, so that with three stations around the world, NASA will always have a "line-of-sight" (direct) communication with a spacecraft as the earth rotates.

A special communications network will support Project Apollo It will include fourteen land stations, five ships, and eight instrumented aircraft. Cable, telephone, teletype and radio circuits with land and satellite terminals will link the stations and the Mission Control Center. The network of tracking stations used for Mercury and Gemini flights will be used to communicate with Apollo spacecraft during the launch, the earth orbital and the reentry phases of the mission. As soon as the spacecraft leaves earth orbit, it will be beyond the range of the Mercury and Gemini tracking stations, and the Deep Space Network will be used for communication with the first men in history to explore the moon. The manned spacecraft tracking network is depicted in Figure 12.

Vocabulary

code
communication
computers
network
orbit
radar
"real time"
relay
satellite
telemetry

Suggested Activities

a. A bulletin board showing the locations of the tracking stations pinpointed on a map will help children visualize where the various stations are located. Connect the various points with yarn for a more colorful and informative display.

b. Have pupils pretend they are from one of the countries where a tracking station is located. They could either write or tell about their impressions of space flight.

c. Set up a series of tracking stations manned by children in the room. Have one child be an astronaut and communicate with the tracking stations during his "journey around the earth".

d. To help children visualize the surface of the earth, talk about flying around the world. Describe what you would see when you look down on the land. How do you think the oceans would look? Children who have had experience in flying should be encouraged to tell what they recall about the appearance of the earth, clouds, roads, houses, etc.

e. Form two teams. Someone on Team A names a tracking station; a member of Team B must locate it on the globe. Keeping score increases interest.

f. In a group of four people one could name a tracking station, one could tell what hemisphere it is in, another could tell the continent it is on, and the fourth could locate it on a map.

g. Have children decide at which of the tracking stations they would most like to work. Have them either write or tell why they chose it.

h. In upper grades where map reading is emphasized, a teacher might pass out a sheet to each student with the name of a tracking station on it. The student would then give its location in terms of latitude and longitude.

Source Materials

Books

The Astronauts Themselves, *We Seven*, New York: Simon and Schuster, 1962 t.

Branley, Franklyn M., *Exploring by Astronaut: The Study of Project Mercury*, New York: Thomas Y. Crowell Company, 1961 i.

Dunlap, Orrin E., Jr., *Communications in Space - Wireless to Satellite Relay*, New York: Harper & Row, 1964 t.

Faget, Max, *Manned Space Flight*, New York: Holt, Rinehart and Winston, Inc., 1963 t.

Thomas, Shirley, *Satellite Tracking Facilities*, New York: Holt, Rinehart and Winston, Inc., 1963 t.

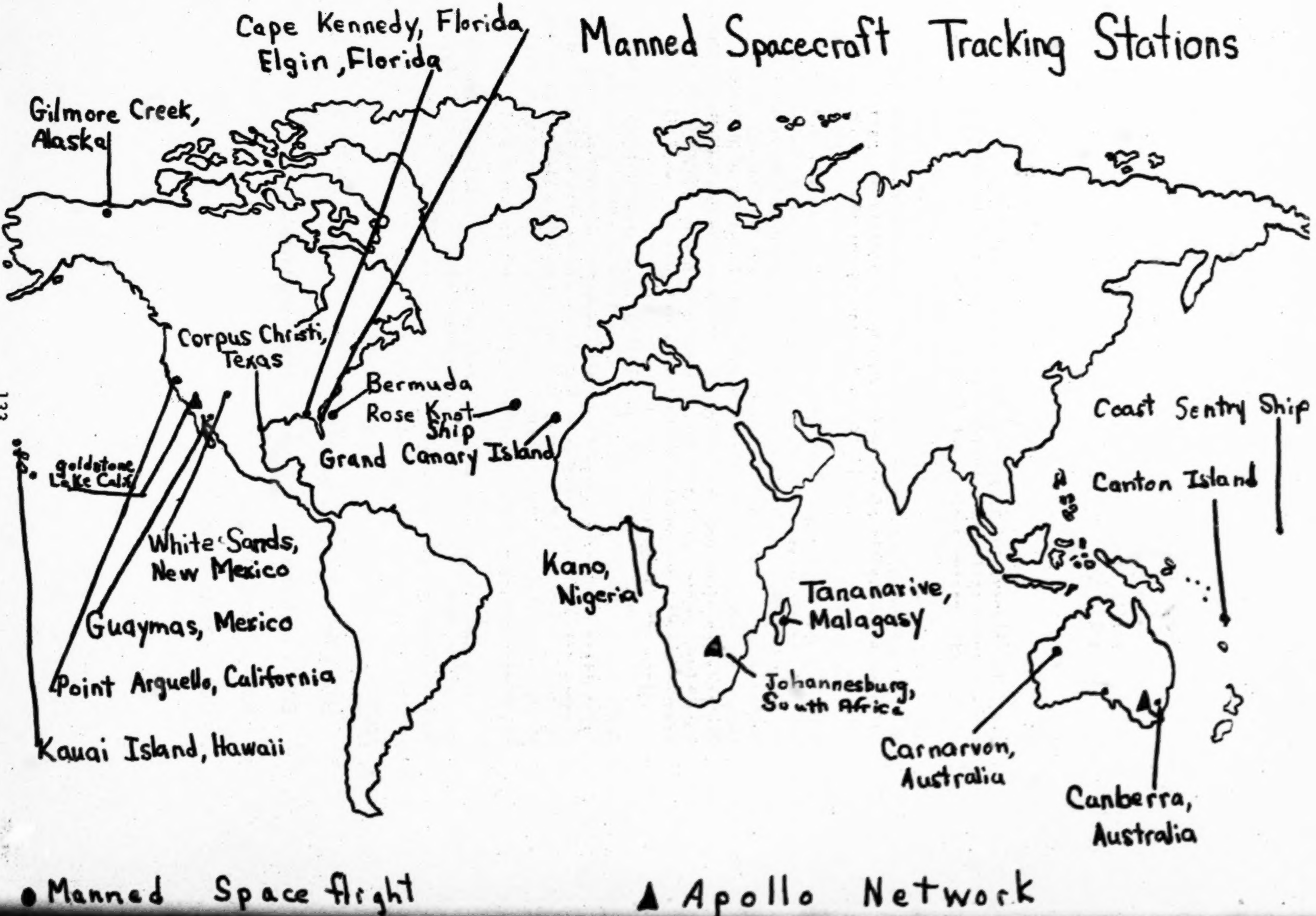
Pamphlet

Tracking, EP-28, NASA, National Aeronautics and Space Administration, Supt. of Documents, U. S. Government Printing Office, Washington, D. C. or address Regional NASA Center; for Nebraska - Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058

Films

Communication: Lifeline to Space, 20 min., USAF, Film Library
John Glenn Story 30 min., color, University of Nebraska
X-15 Documentary, 25 min., Air Force Film Library, S. F. P. 1074
A Voice for Mercury, 4½ min., color, NASA i.
Friendship 7 (MSC-62-124) 57 min., NASA i.
MA-6 Manned Orbital Flight (MSA-62-120) 17 min., NASA
Project Mercury Summation (MSC-64-180) NASA
National Aeronautics and Space Administration, Educational Programs and Services, Washington, D. C. or address Regional NASA Center; for Nebraska - Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058

Figure 12



Manned Spacecraft Tracking Stations

Cape Kennedy, Florida
Elgin, Florida
Gilmore Creek, Alaska
Corpus Christi, Texas
Bermuda
Rose Knot Ship
Grand Canary Island
goldstone Lake Calif.
White Sands, New Mexico
Guaymas, Mexico
Point Arguello, California
Kauai Island, Hawaii
Kano, Nigeria
Tananarive, Malagasy
Johannesburg, South Africa
Coast Sentry Ship
Canton Island
Carnarvon, Australia
Canberra, Australia
● Manned Space flight
▲ Apollo Network

WHAT ARE THEY TALKING ABOUT?

Topic

Space age slang

Background

One result of the space age has been the addition of many new words to our language. Fire the retro-rockets...All systems go... It was a nominal mission..., and many other phrases are now understood and used by many people. Ten years ago, these phrases and the many other expressions of the space age would have been meaningless and unfamiliar. Indeed they did not exist. Today, they are becoming a part of the English language.

The general public, as well as the scientists, is beginning to speak the new language. Television coverage of the events at Cape Kennedy introduced millions of people to the complicated, highly technical lingo of the space age. Broadcasts of communication between the astronauts and Mission Control also fix space age terminology in our language. The entire country was fascinated by reports of g forces, extravehicular activity and reentry phenomena. People watched, listened, and learned some of the technical expressions. Soon, many of the words became part of the nation's speech.

The language of the space age was developed by scientists, astronauts and others through necessity. There were no words to express their ideas and the scientific principles that had been discovered. New techniques, new processes, and all of the revolutionary new equipment had to be named. Words had to be coined in order to describe these innovations. As the exploration of space progresses,more words and expressions will be added to our language.

One must be familiar with the basic words, abbreviations, and acronyms of the space age in order to understand what is happening today. Some of these are listed below.

ACRONYMS

BECO - Booster engine cut-off

ESSA - Environmental Science Services Administration

GOX - Gaseous Oxygen

LOX - Liquid Oxygen

MOL - Manned Orbiting Laboratory
NASA - National Aeronautics and Space Administration
NASCOM -NASA Communications Network
OGO - Orbiting Geophysical Observatory
OSO - Orbiting Solar Observatory
POGO - Polar Orbiting Geophysical Observatory
SECO - Sustainer Engine Cutoff
SYNCOM -Synchronous Communications
STADAN -Space Tracking and Data Acquistion Network
TIROS - Television and Infra-red Observation Satellites

Abbreviations

AMR - Atlantic Missile Range
APU - Auxiliary power unit
CM* - Command module
DME - Distance measuring equipment
EPS - Electrical power subsystem
EVA - Extravehicular activity--"Space walks"
LM* - Lunar module (sometimes called LEM)
OAO - Orbiting Astronomical Observatory Satellite
RCS - Reaction control subsystem
SCS - Stabilization and control subsystem
SM* - Service Module
SPS*- Service Propulsion System
TMG - Thermal meteoroid garment

* Parts of the Apollo Spacecraft

Space Age Slang

A-O-K - operating according to plan; operating perfectly

backup - extra equipment, or systems designed to replace equipment or systems that are not functioning properly

bird - a launch vehicle

black box - any unit or electronic device that can be installed in or removed from a rocket or spacecraft in a single package

boilerplate - a full-scale model that has the weight, size and shape of the true item, but not all of its functional features

burn - period in flight during which rocket engines are ignited and functioning

com - communications or communications system

consumables - those things aboard a spacecraft which are consumed during the mission; includes fuel, oxygen, food, supplies, etc.

debug - to remove malfunctions from a device or to correct mistakes in a system

down-link - that part of the communications system (located on earth) that receives information from the spacecraft (see up-link)

extravehicular - located outside of the spacecraft (antennae, etc)

extravehicular activity - any time spent by an astronaut outside of a spacecraft while in space

escape velocity - the velocity required to propel a craft out of the gravitational field of a body

float bag - a collar placed upright and around the Apollo spacecraft to keep it floating in the water

fly around - an orbit around an object (a planet, a satellite or man-made equipment) in space

go - (as "all systems go" or "go condition") signifies readiness of a system or group of equipment; said of a system or piece of equipment when it is functioning properly

gravity turn - a spacecraft maneuver executed by turning off the main propulsion system and letting gravity pull the spacecraft into orbit around a body in space hard suit - a pressurized spacesuit

injection - the process of accelerating a spacecraft to escape velocity

nominal - contrary to accepted usage this word in NASA language means performing according to plans and specifications; hence, a nominal mission is one that fulfilled the mission objectives

real-time - at the time it is happening; or instantaneously; real-time communications imply no delay in the transmission of the signal

revs - revolutions in orbit

scrub - to cancel a scheduled launch; implies cancellation due to equipment malfunction

stay-time - the amount of time astronauts will remain in space or on the moon

station keeping - the sequence of maneuvers that maintains a spacecraft in a predetermined orbit

t-time - the hour, minute and second scheduled for a rocket launch

up-link system - the part of the communications system which transmits information from the ground to a spacecraft

Suggested Activities

a. Have the children use "space words" in creative writing.

b. Write stories using space jargon and acronyms. Draw pictures illustrating terms and words.

c. Make a personal dictionary listing space terms and words. Have the students make or bring a small notebook to be used for this purpose.

d. Have the children write original acronyms.

e. The class might consider additional ways our language changes and grows--compounding, borrowing, and coining new words.

f. To set up an aerospace communications laboratory you may obtain a Teaching Guide for an Aerospace Communications Laboratory in the Elementary Grades. It was reproduced by the Federal Aviation Agency in cooperation with the Civil Air Patrol. The number of the teaching guide is: GA - 20 - 18 - 66 - 1, 000 Information Office, Maxwell Air Force Base, Alabama

Source Material

Books

Hart, Mark, *Aerospace Word Power*, Preston Idaho: Educational Service, 1961

Moser, Reta C., *Space-Age Acronyms*, *Plenum*, New York, 1964
More than 10,000 acronyms and 17,000 definitions

Verral, Charles Spain, *Go! The Story of Outer Space*, Englewood Cliffs New Jersey: Prentice-Hall, Inc., 1962 i.

Magazine

"Linguistics", *Time*, Vol. 88, July 1, 1966, p. 60 t.

FOOD FOR THOUGHT

Topic

Space food

Background

Nutrition experts and scientists are working at the task of developing concentrated food to provide for the nutritional needs of astronauts in space. The major problem involved is providing enough food for a long period of time in a form that will not be too bulky or heavy for the spacecraft. Much research has been done in this area. The first astronauts ate strained food squeezed out of plastic tubes. This food was not very palatable and occupied too much space in the capsule. The present method of preparing food for astronauts is called "freeze-drying In this process, foods are first frozen instantly and then placed in a vacuum chamber under low pressure. In the chamber the frozen food loses ninety percent of its water content and is changed into a dry product. These foods are then sealed in plastic pouches. Freeze-dried foods retain their natural flavors and are in a chewable form.

Each crew member will be supplied with 1.3 pounds of food per day which at the present time, costs about $27.00 per meal for each astronaut. The food is in the form of dehydrated juices, freeze-dehydrated foods, and compressed non-crumbling bite-sized foods. Cubes of food are coated with an edible film to reduce or eliminate crumbs which under weightless conditions could interfere with crew or spacecraft performance if allowed to float freely.

A menu for a space meal contains two bite-sized foods and two which are mixed with water. A caloric distribution of 17% protein, 32% fats, and 51% carbohydrates is planned so the meals will provide for the nutritional needs of the crew. The following daily menu is typical of the meals eaten by the Gemini astronauts.

Meal A

sugar frosted flakes
sausage patties
toast squares
orange-grapefruit drink

Meal B

tuna salad
cheese sandwiches
apricot pudding
grape drink

Meal C

potato soup
chicken bites
toast squares
applesauce
brownies
grapefruit drink

Water for reconstituting foods was carried in storage tanks on Gemini missions. The astronauts used small water guns to force water into the tubes containing food. Water produced by the fuel cells on Apollo spacecraft will be used to reconstitute the dehydrated food. On Apollo flights, cold water and hot water will be available for preparation of hot and cold foods. Having hot tea and cold orange juice will be a significant improvement over the tepid space foods served on previous flights.

Vocabulary

balanced
calorie
carbohydrates
compressed
dehydrated
dispenser
edible
fats
nutrition
protein
palatable
reconstitute

Suggested Activities

a. Use the following questions for discussion:
   What is a well-balanced diet for a ten year old boy; an athlete; an astronaut?
   How many calories would each need? Why?
   Why do astronauts need special containers for food and water?
   Why do astronauts need six pounds of water a day?
   How can we use the ideas of space foods and packaging in daily living?

b. Fill clear plastic sandwich bags or other clear plastic containers with blended or strained foods. Seal the top of the bag with plastic tape and cut off a corner. Let the children try to eat like the astronauts do on space missions.

c. Find out how the body uses water.

d. List the ways man uses water to maintain health.

e. Find out how much water two astronauts would drink in four days.

f. Find out how many calories the three astronauts in the Apollo spacecraft would need for eight days.

g. Plan a nutritious diet for an astronaut, a ten year old boy, an athlete. Compare the difference in calories, carbohydrate, protein and fat content. Results could be arranged on a bulletin board.

h. Plan ways in which the concepts of space food and packaging can be used in daily life. (example: camping).

Source Materials

Books

Bergaust, Erik, Rockets to the Moon, New York: Putnam's Sons, 1961 i.
Coggins, Jack and Pratt Fletcher, By Space Ship to the Moon, New York: Random House, 1952 i.
Faget, Max, Manned Space Flight, New York: Holt, Rinehart and Winston, Inc., 1965 t.
Henry, James, Biomedical Aspects of Space Flight, New York: Holt, Rinehart and Winston, Inc., 1956 t.
NASA Facts
Nutrition in Space, Project Gemini, 65052 HISD-IB-GM, #1002
Foods for Use in Space, 650315-HISD-EB-GM #1003
National Aeronautics and Space Administration, Supt. of Documents, U. S. Government Printing Office, Washington, D. C. or address Regional NASA Center; for Nebraska - Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058

Films

Menu for Space Flight, (MSC-64-178) 6 min., color, 1963 NASA
Food for Space Travelers, HQK SR3, 28 min., 1966 NASA
National Aeronautics and Space Administration, Educational Programs and Services, Washington, D. C. or address Regional NASA Center; for Nebraska - Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058

THESE BOOTS ARE MADE FOR WALKING

Topic

Space walk

Background

Both the United States astronauts and Russian cosmonauts have carried out extravehicular activity (EVA) in their manned space programs. The first space walk was accomplished by the Russian, Leonov, on March 18, 1965. To date this is the only space walk the Russians are known to have attempted.

Edward H. White II on the Gemini IV flight was the first American astronaut to walk in space. Astronaut Eugene Cernon carried out the next space walk in June, 1966 and encountered several difficulties. Tasks seemed to be much more difficult than anticipated, causing such exertion that the fogging of his visor became a serious problem. Cernon also became quite warm and even while he rested these conditions did not improve. Manipulative tasks were quite difficult for the astronaut to handle. Cernon's voice was described by the command pilot as a "lot of garble."

Michael Collins made the next walk in space on July 18, 1966. Collins used a "hand-held maneuvering unit" but the experiments were not completed because they had to conserve fuel in preparation for their return to earth.

Richard F. Gordon Jr's. space walk in September of 1966 was terminated when perspiration started gathering in his right eye impairing eyesight.

The space walk by Edwin R. Aldin Jr. was the most successful of all walks made on Gemini missions. Aldrin logged more EVA time than any man. The use of handrails, foot restraints, and waist tethers during the umbilical EVA period corrected difficulties encountered on other missions. Aldrin completed all of nineteen assigned tasks.

Vocabulary

astronauts
cosmonauts
exertion
extravehicular activity
garble
logged
maneuvers
manipulative
restraints
umbilical cord
visor

Suggested Activities

a. Children could illustrate what they think they would see while taking a space walk using tempera, finger paints, or crayon drawings.

b. Discuss the feeling of weightlessness with children. To get an idea of what weightlessness or zero gravity is like, consider the sensation you feel when the automobile you are in hits a bump and you are "floated" out of your seat for a moment or when you get on an elevator at the 15th floor and it drops suddenly, leaving you with your "heart in your mouth." When going over the rise of a roller coaster, swimming and diving in a pool, sky diving in free fall, you will experience a sensation similar to weightlessness.

c. As an assignment in creative writing, have pupils describe what it would feel like to walk in space.

d. Have children make creative abstract drawings expressing feelings experienced and colors perceived while space walking.

e. Create a dance trying to show the various movements of space walking.

Source Materials

Pamphlet

A Walk in Space, EP-26, Supt. of Documents, U. S. Government Printing Office, Washington, D. C. or address Regional NASA Center; for Nebraska - Educational Programs and Services AP4, NASA Manned Spacecraft Center, Houston, Texas, 77058

Films

Free Fall in Space, color, 8 mm., single concept, Film Associates, 11014 Santa Monica Blvd., Los Angeles, California 90025

A Walk in Space I

A Walk in Space II, color, 8 mm., single concept, Communications Films, 370 Monterey Pass Road, Monterey Park, California 97154

Filmstrip

First Adventures of Space (series), Jam Handy Co., 2821 Grand Blvd., Detroit, Michigan 48211

DOCTORS FOR SPACEMEN

Topic

Space medicine

Background

In order to assure the safety of astronauts on missions in space, a new branch of science called space medicine is developing. Doctors in this field are working to understand how the body reacts to the strains of spaceflight and to the environmental conditions in space. Since the early stages of the manned space flight program, doctors have worked hand in hand with the other scientific personnel to assure that the astronauts are physically prepared to withstand the strains of space travel and to design equipment that will protect them from the hostile conditions in space.

There are many forces involved in space travel which could have adverse effects on the astronauts. The initial phases of the mission--the lift off and the flight out of the earth's atmosphere--are very difficult for the body to withstand. The forces exerted on the body by the rapid acceleration make it up to ten times heavier than normal. These forces distort the astronauts' features, respiration rate increases from sixteen breaths per minute to forty per minute, and vision is distorted. The pull of gravity slams the men down into their seats and makes it impossible to move.

To minimize the effects of these strains on the human body, doctors, working with spacecraft engineers, designed couches which place the astronauts in a horizontal position. The body is better able to withstand the forces of launch in a nearly prone position.

After the tremendous strains of launch, the astronaut's body is subjected to the weightless conditions of outer space. Doctors are just beginning to understand the medical implications of weightlessness. It is known that zero-g conditions cause the muscles to weaken because they do not have to work against the force of gravity. Weightless conditions cause bones to lose calcium and cause the circulatory system to deteriorate. In addition, a prolonged absence of sensation in the inner ear and on the weight bearing muscles may cause astronauts to lose a sense of balance and coordination.

To overcome some of these adverse effects of weightlessness on the human body, doctors have developed isometric exercises, a type of exercise which strengthens muscles by working them against other muscles or against solid objects. Special body-building equipment has also been provided for use in spacecraft. One such item is a spring-tension device enabling crew members to exercise by stretching, pulling, and pushing.

Before man ever ventured into space scientists knew that man cannot live in the vacuum of space because the human body cannot function without air pressure and without oxygen. Doctors working with space medicine have helped develop space suits and pressurized cabins to protect astronauts against the vacuum of space. Doctors have also done research to determine the minimum air pressure under which the body can function properly and to determine the best combination of gases for breathing.

Protecting astronauts from radiation is another major concern of space medicine. Doctors and scientists are working to identify the amount of radiation present in space. They hope to establish safe limits for exposure to the space radiation and to design a garment which will protect men from its harmful effects.

Adverse physical conditions are not the only problems an astronaut encounters; psychological problems are also a major area of concern. Emotional difficulties, such as "break-off" (overwhelming sensation that all contact has been lost with earth), hallucinations, claustrophobia, boredom, and fear will affect astronauts throughout the flight. To relieve this tension, scientists will provide radio contact with earth, relay messages to the family, and make every effort to provide for the comforts and needs of the spacecraft crews.

The reentry phase of the flight also subjects astronauts to harmful forces. During reentry, the capsule slams into the earth's atmosphere much as if it were an automobile being driven into a brick wall. The astronauts again are subjected to tremendous strains from the force of gravity. Again, their faces are distorted, their breathing accelerated and their vision blurred.

Russians, as well as Americans, are very concerned with medical findings of the previous space flights. After flights both Russian and American spacemen have shown significant, though temporary, physical disturbances. Space travel has affected their circulatory systems, central nervous systems and metabolism, the most striking symptom being the occurance of low blood pressure as a result of reduced blood vessel elasticity. The medical findings of the first space flights have served to underline how much is still not known about space medicine.

Vocabulary

adverse
astrobiologists
claustrophobia
deterioration
distorted
environment
hallucinations
isometric
pressurized

Suggested Activities

a. The children could practice some of the following isometric exercises. All exercises should be performed for 12 seconds each, once a day.

1. Lie on back with arms fully extended, elbows locked, palms up. Partner applies downward pressure at wrists. Exerciser pushes toward pressure, and holds for 12 seconds.
2. Lie on back. Have partner apply pressure on forehead. Push against pressure. Hold 12 seconds. Have partner hold back of head. Push against partner. Hold 12 seconds. Use same procedure on left and right sides of head.
3. Lie on back, legs fully extended, knees locked. Have partner apply downward pressure at ankles one leg at a time. Exerciser lifts leg straight up against pressure.
4. Lie on back with legs bent at the knee. Have partner apply downward pressure at ankles. Exerciser applies upward force.

b. Make a bulletin board with pictures, drawings, or diagrams of optical illusions.

c. Encourage the pupils to bring news clippings and data collected from magazines, concerning the effects of space travel on man.

Source Materials

Books

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Lent, Henry, Man Alive in Outer Space, New York: MacMillan, 1961 i. t.
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Stone, Marvin L., Man in Space, New York: Nelson Doubleday, Inc., 1965
Williams, K. G., New Frontier: Man's Survival in the Sky, New York: Charles C. Thomas, 1964 t.

Films

Medical Aspects of Space Flight, NASA t.
Space Medicine, NASA
National Aeronautics and Space Administration, Educational Programs and Services, Washington, D. C. or address Regional NASA Center; for Nebraska - Educational Programs and Services, AP4, NASA Manned Spacecraft Center, Houston, Texas 77058
Universe From Within, the Aerospace Medical Division, USAF Film Library

Filmstrips

Gravity, the Big Pull, #A-420, color, Curriculum Materials Corporation, 1319 Vine St., Philadelphia, Penn. 19107 p.
How an Astronaut Lives in Space, Filmstrip House, 432 Park Ave., South New York City, New York 10016 i.

TABLE VI

RUSSIAN COSMONAUTS AND HIGHLIGHTS OF FLIGHTS

COSMONAUTS	DATE	REVOLUTIONS	SPACECRAFT NAME	ACCOMPLISHMENTS
Major Yuri Gagarin	4-12-61	1	Vostok I	First manned orbital flight, apogee of 188 miles.
Marjor Gherman Titov	8-6-61 to 8-7-61	17½	Vostok II	Two-day flight.
Major Andrian Nikolayev	8-11-62 to 8-15-62	64	Vostok III	First "tandem" flight.
Pavel Popovich	8-11-62 to 8-15-62	48	Vostok IV	Flew with Vostok III; cosmonaut "floated" 3½ hrs.
Valery F. Bykovsky	6-14-63 to 6-19-63	81	Vostok V	Biomedical research on effects of prolonged manned flight.
Valentina V. Tereshkova	6-16-63 to 6-19-63	48	Vostok VI	First woman in space.
Col. Vladmir M. Komarov, Konstantin P. Feoktistov (scientist) Boris B. Yegorov (physician)	10-12-64 to 10-13-64	16	Voskhod I	First three-man space flight
Aleksei A. Leonov Pavel I. Belyeyev	3-18-65 to 3-19-65	17	Voskhod II	Leonov took a 10 min. "space walk" with an "autonomous life support system".
Vladmir Komarov	4-23-67		Soyuz I	Cosmonaut and capsule lost during reentry.

THE VASTNESS OF SPACE

THE VASTNESS OF SPACE

OVERVIEW

Everything in space is part of the universe. Throughout history, man's ideas about the cosmos have constantly changed. Ancient man fabricated many stories in an attempt to explain what he observed in the universe. Many of the ancient peoples thought that Earth was the center of the universe, and the moon and the stars revolved around it. The work of astronomers such as Pythagoras, Kepler, Galileo, Copernicus, and Newton taught man that Earth was not the center of creation.

The size of the universe is thought to have no limits. The distant galaxies seem to be moving rapidly away from the sun. The most distant galaxies probably are moving fastest. Thus, it seems to some scientists, that the universe is expanding. Other scientists believe that the universe is not expanding and are looking for some law of nature which will explain the reason why the galaxies seem to be moving away from the sun.

These lessons have been developed to help children gain a better understanding of space and the celestial bodies which lie beyond the earth.

THE WORLDS BEYOND

Topic

The universe

Background

The universe may be defined as the whole of space and all the bodies in it. Our galaxy, the Milky Way, is just one member of a still larger unit called the Local Group. This includes seventeen or more systems, all held loosely together by gravitational force within a radius of fifteen million light years. Near one end of this vast super-system, the Milky Way circles like a glowing wheel.

As the eye of the telescope peers outward, it gazes past the familiar constellations and sees the more distant star clouds and clusters of the Milky Way.

Farther out there are other galaxies. Each one is made up of billions of stars. They are so vastly distant that their light takes many millions of years to reach Earth.

About a trillion galaxies lie within the range of our largest telescopes. Probably all the galaxies were created at about the same time. Most astronomers believe it was about five billion years ago.

"Galaxy" comes from a greek work meaning "milk." The Milky Way is a band of light that stretches across the sky. It can best be seen on a clear, moonless night in midsummer or midwinter.

Galileo solved the puzzle of the Milky Way by turning his telescope toward it about three hundred years ago. His telescope showed clearly that the band of light comes from an enormous number of distant stars. They are too far away to be seen separately without a telescope. With the use of a telescope, the stars in the Milky Way give the appearance of a shining cloud.

The diameter of the Milky Way System is given as 100,000 light years. Astronomers have found it quite inconvenient to measure distances in space by earth miles. Space is so vast that a new measuring stick had to be invented. The best way to deal with such distance is in terms of light years. Light travels at just over 186,000 miles per second. One light year is the distance which light can travel in a year. When we look at the nearest of the brilliant stars, Alpha Centauri, we are looking back into time more than four years. If we should see it explode, we would be watching something that happened four years ago, the time it takes light to reach us from that star. The farthest light in the sky visible to the unaided eye is the Great Spiral in Andromeda, 1,500,000 light-years away. Scientists have found ways to measure the distance to a star. For the nearer stars they can use the parallax method. The parallax of a body is merely its angular displacement as seen from two stations a known distance apart. For the more remote stars scientists use instruments based on the spectroscope which make it possible to analyze starlight, and thus determine a star's distance from the earth.

Vocabulary

Andromeda
astronomers
constellations
galazy
intensity
parallax
trillion
spiral

Suggested Activities

a. The distance between the earth and the moon and the difference in their sizes can be illustrated to the class using a 12-inch globe and a 3-inch styrofoam ball. Using the scale 8,000 miles equals one foot, (the earth's diameter, 8,000 miles , is represented by one foot on the globe) the moon would be a 3-inch sphere located 30 feet away. Since the moon is 240,000 miles from the earth, the distance was determined using $\frac{240,000}{8,000}$ = 30 feet.
The playground or football field may have to be used to show 30 feet if the classroom is too small.

b. The actual numbered miles in a light year may be computed by multiplying the speed of light, 186,300 miles per second, by the number of seconds in a year. Another way of attacking the problem is to realize that there are 60 seconds in a minute, 60 minutes in an hour, 24 hours in a day, and 365 days in a year. Solve the following problem: 186,300 x 60 x 60 x 24 x 365 = ? Round off answer to nearest billion miles.

c. How long is 8 seconds? Develop this concept to demonstrate how long it takes the light to come from the sun to the earth.

d. Visit a planetarium if there is one near you.

e. Pupils could make reports on some of the ancient beliefs on the creation of the universe and discuss theories scientists have formulated concerning the creation of the universe.

f. Encourage the children to find out about the nature of stars, stellar explosions, galaxies, and other celestial phenomena.

g. Work with the idea of the vastness of the universe by comparing the size of the following: a child, a building, the earth, sun, our galaxy, and the universe.

h. Introduce children to the relative distances in space using Harold Pluimer's* "Want to Develop a Concept of Space and Time."

i. In order to give pupils the idea of parallax have them hold a ruler at arm's length. Line it up with a distant object (such as a tree or a post) using only one eye. Now, without moving the head or the ruler, sight the object with the other eye. The angle by which the object seems to have moved is a measure of parallax.

Source Material

Books

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Hoss, Norman, How and Why Wonder Book of Stars, New York: Grosset, and Dunlap, 1960 p. i.
Navarra and Zafforoni, Science Today for the Elementary School Teacher, Row, Peterson and Co. t.
Parker, Bertha Morris, Beyond the Solar System, Evanston, Ill., Row, Peterson and Co., 1957 t.

Films

The Sun's Family, 7½ min., b/w, YAF McGraw-Hill i.
Exploring Night Sky, 7½ min., Encyclopedia Britannica Films i.
Understanding Our Universe, 7 min., b/w, Coronet i.
What Do We See in the Sky, 7½ min., b/w, Coronet i.

Filmstrips

Astronomy Through the Ages, p. i.
The Earth: Its Neighbors in Space, p. i.
Exploring the Moon, i.
The Milky Way and Other Galaxies, b/w, p. i.
Nebulae, b/w, i.
The Moon, p. i.
Planets and Comets, b/w, i.
The Seasons, color, p. i.
Solar System, i.
The Solar System, p. i.
The Universe, S-4C, Exploring the Sun, color, McGraw-Hill, p. i.

* See page 153 for Mr. Pluimer's article.

Transparencies

Celestial Navigation, #258-543, General Aniline and Film Corp. i. j.
The Milky Way, #258-503, General Aniline and Film Corp., two overlays Physical Science. i. j.

Flannel Board Aids

The Solar System
The Earth and Its Moon

School Specialty Supply
212-14-16 Santa Fe Street
Saline, Kansas 67401

Flash Cards

Know Your Stars and Planets, Rand McNally

WANT TO DEVELOP A CONCEPT OF SPACE AND TIME?

by

Harold P. Pluimer

The most illusive of all science concepts is that of time and space. In this era of aerospace we glibly speak of lunar voyages, Martian expeditions, or other solar journeys. Many people, including some teachers, do not have the remotest idea of the distances involved, much less a genuine appreciation of cosmic concepts. In this respect most textbook illustrations and wall charts lead to more misconceptions than a realization of the magnitude of stellar dimensions.

One simple technique that has been very effective is to reduce the solar system down to comprehensible dimensions. Rather than scaling down either the sizes of the planets or their distances from the sun, both will be scaled downward by the same factor. Herein lies the value of this exercise, and the outcomes to be gained will be expressed only as youngsters can exclaim.

Our plan is to scale down the solar system by a factor of fiteen billion! In other words, our scale will be one inch = 250,000 miles. Even at this degree of reduction the solar system would not fit into the largest classroom. To reduce the scale even more would render the smaller planets invisible. One immediately recognizes the difficulty of the problem at hand, however, with a little ingenuity scotch tape, and adding machine paper our problem will become less formidable.

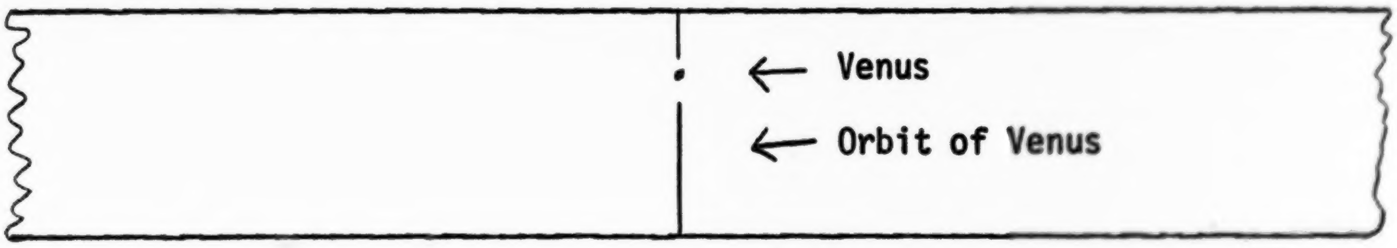
Procure from the office two or three rolls of adding machine tape. This, as you will see, is the most difficult aspect of our project as some administrators will question the accountability of using tape for, of all things, a science project.

Use the data shown on page 155 as a guide to draw and place the members of our solar system in their respective positions.

On one end of the tape draw the sun to scale, that is reducing its diameter by a factor of 15 billion. Our Sun, having a diameter of approximately 800,000 miles, will be represented by a circle 3.2 inches in diameter. (A double width of paper will have to be used to include the entire diameter.)

Thirty-six million miles from the Sun is Mercury. Not only is it the closest planet but the smallest as well, having a diameter of approximately 3,000 miles. Unroll the paper tape to a point 144 inches from the Sun and our first planet will be represented by a tiny, almost invisible, dot 32 thousandths of an inch in diameter. This is equivalent to a dot made with a sharp pen. The fact that the planet is represented by an insignificantly small speck 12 feet away from a somewhat larger speck will actually enhance the development of our concept.

Continue placing the planets in their respective positions according to the data furnished in the table. It may be well to indicate the orbits of the planets by positioning the dot between lines representing the path of the planet about the Sun. It would appear similar to the sketch below.



You may, if you wish, include with the earth its moon. According to our scale its position will be represented by a circle with a radius of one inch. Obviously, its size cannot be plotted, however, the circle will represent its orbit. You may also point out here that overcoming this distance (240,000 miles or a little less than one inch on the tape) will be the culmination of the most ambitious project that man has ever attempted.

It is suggested that descriptive drawings of the planets on 8½" x 11" paper be made to accompany the planetary dots. You may plot as many planets as you wish, but, some limitations will soon become apparent. The second roll of machine tape may be scotch-taped to the first to provide for a continuous roll. The school corridor would be the most likely area to display the project as it will invoke the curiosity, and hopefully the amazement of other pupils in the building.

As an added inducement, after kindling their imagination, you may ask the pupils to calculate the approximate positions of the nearest star, Alpha Centauri, Polaris, or even our sister galaxy Andromeda. Believe it or not, the North Star, even at our reduced scale would be a three-inch speck more than one-half way to the moon! Obviously, the only conclusion that can be reached is that the Universe, or the solar system, is almost completely empty space.

As a clincher you may want to embark on an imaginary journey to one of our solar neighbors. After the exhibit has been placed in the hall a plastic rocket may be used and moved daily. Let the pupils select their rocket speed although the velocities should conform to present day attainable speeds such as 25,000 m. p. h. It should be kept in mind that while the rocket is proceeding toward its objective the target planet, and of course your rocket, are moving in orbit about the Sun.

P. S. Take plenty of bubble gum along.

Body	Diameter	Distance from Sun	Scaled Diameter	Scaled Distance	Remarks	No. of Moons
SUN	800,000 mi.	------	3.2"			
MERCURY	3,000 mi.	36 million mi.	.012"	12'	144' from Sun	0
VENUS	8,000 mi.	67 million mi.	.032"	22.3'	10.3' from Mercury	0
EARTH	8,000 mi.	93 million mi.	.032"	31'	8.7' from Venus	1
MARS	4,200 mi.	141 million mi.	.016"	47'	16' from Earth	2
JUPITER	87,000 mi.	483 million mi.	.35"	161'		11
SATURN	71,000 mi.	886 million mi.	.28"	295'		9
URANUS	32,000 mi.	1.8 billion mi.	.13"			5
NEPTUNE	31,000 mi.	2.8 billion mi.	.13"			2
PLUTO	6,000 mi.	3.7 billion mi.	.024"			0
Alpha Centauri Polaris Andromeda		4.5 LY* 300 LY 1.5 million LY			1 LY = 6 trillion miles trillion miles	

ONE INCH = 250,000 miles

* LY = light year

THE PICTURE BOOK IN THE SKY

Topic

The study of constellations through myths

Background

Many thousand years ago, man looked out of his cave and wondered at what he saw. Why did the sun rise and set? What caused the different shapes of the moon? What was lightning? Where did fire come from?

Since man did not have sufficient knowledge to solve these problems, he invented his own answers. He reasoned that all of these forces must be created by huge and powerful beings. Primitive man made up stories about their immortal gods who possessed supernatural powers. These stories are called myths. So strong were these beliefs that man developed mythology as a religion. Callisto, the beautiful maiden who was changed into a bear by Juno; Bellerophon, who rode the winged horse Pegasus; the Pleiades, seven dancing Indian children; Cassiopeia, the beautiful but proud queen; and Orion, the hunter are but a few of the many myths related to the universe.

The following myths represent primitive man's attempt to explain the heavens. These selections are examples of both Greek and Indian mythology.

ORION, THE MIGHTY HUNTER

Orion, like many of the other heroes found among the stars, was once a man who lived on earth. But even while he roamed the earth, Orion, the hunter and mighty warrior, was no ordinary man. His father was the god Neptune who allowed him to walk unharmed on the waters of the earth.

There are two stories about how he happened to be placed among the stars. In the first story, Orion, the mighty hunter fell in love with Merope, the daughter of Oenopion, an island king. The couple wished to marry, but her father opposed the match. In order to prevent the marriage he found reason after reason for not considering it. Often he sent Orion on dangerous missions promising to consider the marriage when Orion had returned.

Finally, the king thought of a plan to get rid of Orion. He decided to send the giant on a very dangerous mission. The king told Orion that if he cleared the island of all of the wild beasts he could have Merope's hand in marriage.

Orion was a bold and skillful hunter, and in a very short time, he had killed all of the wild beasts on the island so that men could walk unharmed in the forests. He returned to tell of his success and claim his bride, but the king found another excuse for postponing the wedding. Then Orion realized that the king had no intention of permitting him to marry the girl that he loved. Burning with anger, he made a plan to carry the girl away. A spy found out about the plan and told the king about it. Orion was arrested and put into jail. So enraged was the king that he had the giant blinded and cast out helpless in a dark world.

The mighty giant wandered alone and sightless on the seashore and he wept for his fate. Without eyes he could no longer see the wonderful sights on earth--the sea, the flowers, and the beautiful sun in the sky. He could no longer hunt, for his eyes saw only blackness. The loss of his sight added to the loss of his love made Orion want to leave the earth. Suddenly, in the distance, he could hear the sound of Cyclops's hammer. He followed the sound to the forge of Vulcan. He begged the god to restore his sight. Vulcan took pity on the mighty giant and asked one of the blacksmiths to guide Orion to the land of the sun. They walked, Orion carrying the guide on his shoulders, until they found the sun. They found it in the land far, far to the east where the sun-god rises. The sun was in its full glory when Orion stepped above the horizon. He opened his sightless eyes and looked toward the brilliant sun. Still blind, he sank in despair. Then gradually, the light began to come through his eyes. At last his vision cleared, and once again the mighty giant Orion could see. After his death he was placed in the heavens as a constellation. At night you can see the stars that mark his spot in the sky.

ORION AND DIANA

The second story about how Orion was given a place among the stars concerns his love for Diana, the Goddess of the Moon.

At night Diana usually rode her pale chariot across the sky and gave moonlight to men on earth. However, she was very fond of hunting, and on some nights she went into the forest and did not drive her chariot across the sky. When Diana went hunting there was no moonlight. It was on one of these dark nights in the forest that she met Orion who was also a skillful, devoted hunter. Diana was one of the most beautiful goddesses, and Orion was as handsome as any of the Gods. The couple fell desperately in love. For Diana, there was no pleasure except being with Orion. She left her chariot every night and the earth was in total darkness at night. Those who prayed to her received no answer because she did not think of anything but her lover.

Her brother, Apollo was furious when he found that she was not driving the chariot of the moon and that she had fallen in love with a mortal. Several times he spoke with her, trying to convince her to give up her lover, but Diana did not pay attention to his demands. She could only think about Orion. "As long as Orion remains on earth, I too will stay," she said to her brother.

The mighty god, Apollo, who ruled over the sun in its path across the skies decided that something must be done to free his sister from her love for Orion. One day at noon as he was driving his chariot across the sky he noticed Orion swimming near the seashore. He decided to trick his sister into shooting Orion. He gathered up all of his sunbeams and focussed them on Orion the swimmer. Then he challenged Diana to prove her skill with a bow and arrow. "See that dark object on the horizon," he said, "I will bet that you cannot hit it from this distance." Diana loved a challenge and immediately took aim with her weapon. She drew the bow and let the arrow fly. So accurate was her aim that the arrow pierced Orion's head and killed him instantly. Diana, triumphant because she had hit her target, laughed and made her brother say that she was an excellent huntress.

That evening Diana drove her chariot to the place where she was to meet her lover, and instead of finding Orion, she found his body with her arrow still implanted in the head. Diana was grief stricken and wild with rage at what her brother had tricked her into doing.

Finally, in despair, she put her lover's body into her chariot and drove up the steep incline of the sky. In a spot where the sky was the very darkest she placed Orion. Stars outlined the figure of the hero, his head, his shoulders, his sword and belt; even the lion's skin he had always carried thrown over his arm was sprinkled with stars. To make him feel at home in the sky, Diana placed his two favorite hunting dogs beside him and marked each with a brilliant star. When she saw how beautiful the stars were, she was pleased. Apollo would forever be jealous of Orion's beauty and always reminded of his treachery. Diana never recovered from her grief and her heart turned cold. Ever since then, the face of the moon has been cold and lifeless in remembrance of Diana's grief.

THE STORY OF THE TWO BEARS

Long ago in ancient Greece a beatuiful woman, a mortal, named Callisto, stood between the white marble columns of her home and watched the darkness come over the sea. She was draped in the white folds of a Grecian robe, and her lovely hair shone in the soft light of the evening. Beside her stood her little boy, Arcas. This evening Callisto was telling her son about the stars. Since Greece is surrounded by water, the stars appear to rise and set in the water; consequently, the Greeks believed that Neptune, the god of the sea, ruled over stars when they traveled through his kingdom. As Callisto stood at the edge of the sea, Juno, the queen of the gods noticed Callisto's lovely face and wonderful hair. Juno was very jealous of beautiful women and she vowed to get revenge on this mortal who dared to be more beautiful than a goddess.

As it happened, Callisto's favorite sport was hunting. Often she left her son with a nurse and taking her bow and arrow, she went to the deepest part of the forest where it was dark and cool. There, one day, Juno appeared before Callisto. Juno stood still looking at Callisto's beauty while jealousy made her more and more angry. Callisto was frightened but she did not run away. Suddenly her feet and hands began to feel numb. She looked down and saw her feet and hands turn into huge paws. Black fur slowly began to cover her slender, white legs and arms. Juno's anger had turned her into a bear.

The years passed and Callisto, the bear, lived in the forest without ever seeing her home or family. Then one day, a young hunter came into the forest and Callisto recognized that he was Arcas, her son, who had grown into a fine young man.

When she saw her son, she ran to embrace him, but Arcas was a skillful hunter and as the bear came toward him, he raised his spear. He prepared to drive the spear deep into the bear's throat, not knowing that it was his own mother.

Jupiter, the king of the gods was annoyed at the things that his jealous queen did, and decided to save the bear. He could not undo what Juno had done because she was a goddess; therefore, in order to save Callisto's life he changed Arcas into a bear, too. Jupiter knew that Juno might harm the two bears if she found out that he had saved Callisto, so he put both bears up into the sky. When the vain, jealous queen saw what Jupiter had done, she went to Neptune and made him promise never to let the two bears come into his kingdom.

Since that time, the constellation of the two bears has wandered in a circle in the sky. That is how the Greeks explained why they do not rise and set like other stars.

CASSIOPEIA

Once there lived a queen, Cassiopeia, who had a very beautiful daughter named Andromeda. The proud queen boasted that her daughter was even more beautiful than the sea-nymphs, the children of the powerful god, Neptune.

An absolutely certain way to bring a wretched punishment to oneself was the claim to be superior to the gods. Neptune, of course, was enraged when he heard about Cassiopeia's boast, and in revenge he sent a monster to attack the queen's country. The creature laid waste the shores, and before long the queen and her husband, Cepheus were desperate.

What were they to do? Cepheus consulted the Oracle, and was told that the only way to save his country was to chain the lovely Andromeda to a rock so she could be eaten by the monster. Grief stricken, Cepheus gave the necessary orders, and Andromeda was left alone to await the frightful beast.

It so happened that the hero, Perseus was flying home carrying the head of Medusa, whom he had just killed. He saw Andromeda chained to the rock and swooped down to investigate. At that moment Cetus, the monster, appeared but when it saw the gory head which Perseus carried, the monster turned to stone. The beautiful girl was saved, and Perseus was rewarded with her hand in marriage. They lived happily together for many years. Cepheus and Cassiopeia continued to rule their country in peace and prosperity.

All of the characters in this story were later turned into constellations. Now they remain in the sky preserving their story for all time. Andromeda is a long chain of stars between the stars of Perseus. Pegasus stands on the road of the Milky Way with Medusa's head swinging from his belt. Cepheus and Cassiopeia, far to the north look down on the scene. Neptune's daughters, the nymphs, decided to take an eternal revenge on Cassiopeia. They bound her to her chair in the heavens and placed her so that she revolves around the Pole Star. For all time she must spend half of every night hanging upside down in the sky.

THE STORY OF PEGASUS, THE WINGED HORSE

Once, long ago, there lived in ancient Greece a terrible monster who lay waste to large areas of the countryside and killed hundreds of men, women, and children. The monster had three heads. One of them was a lion's head, one a goat's head, and the largest and most hideous was a dragon's head. From his three mouths the monster belched fire and smoke, killing every plant and animal for miles around. Many brave men died trying to kill the monster, and it seemed that no one would be able to succeed.

One day Bellerophon, an exceedingly brave young Greek decided to kill the monster and save his countrymen. Bellerophon thought and thought, but could not think of a plan to kill the monster. Then one night in a dream a goddess came to him and presented him with a golden bridle covered with jewels.

"Take this bridle", the goddess said, "and go to the spring where Pegasus, the winged horse drinks. Bridle him with this jeweled halter and ride on his back to attack the monster."

Bellerophon woke from his dream and finding the bridle just as the goddess had promised, he left to find the wonderful, winged horse. The young man walked to the spring but had to wait a long time to see the horse. Finally Pegasus flew down to the spring. What a magnificent sight he was with his beautiful white coat and pair of lovely wings. Bellerophon immediately decided that he must master this wonderful horse. He tried to catch him and slip the bridle over his head, but the spirited Pegasus was determined not to be captured. Finally, after three or four days Bellerophon saw Pegasus come to drink early one morning. He held the golden bridle exactly right and sprang forward. It slipped over the head of the startled horse. Then, Bellerophon leaped onto the back of his wonderful horse. Pegasus flew up into the air and bucked and kicked in an attempt to shake the rider off of his back. Bellerophon held on for all of his might and the horse finally realized that he had a master.

Next, Bellerophon on his magnificent, winged, white horse started out to find the monster. They found his cave and hid themselves to wait for the monster to come out. Bellerophon finally heard a low rumbling from the cave and suddenly the first of the heads appeared. It was the goat's head, with its terrible horns and red eyes. The mouth opened and foul smelling stream of fire and smoke poured out. Next the horrible lion's head appeared. It had a matted mane and hideous teeth. Next the dragon's head woke up and emerged from the cave. The sight was so terrifying that Bellerophon almost ran away, but he saw that Pegasus was not afraid.

With new courage, he mounted his horse and drew his sword. Pegasus spread his wings, flew over the monster, and Bellerophon cut off the lion's head. Infuriated and in pain, the monster shot a huge blast of flame into the air, but Pegasus was so swift that the monster missed him. Down flew Pegasus again and Bellerophon cut off the lion's head.

The monster spewed forth fire and smoke. He clawed in the air and beat the ground with his tail, but again Pegasus carried his master out of harm's way. Finally, as Pegasus flew down for the third time, Bellerophon shot the remaining head with an arrow. The monster at last had been killed.

After the battle, Jupiter decided to honor Pegasus by putting him up with the stars where he could run, graze and play for all time. If you look into the sky on a dark autumn evening you can still see his stars shining there.

THE SEVEN SISTERS

Inventing stories to explain the mysteries of the universe was not unique to the ancient Romans and Greeks. There is an interesting Indian myth about the star cluster sometimes called "The Seven Sisters".

A long time ago a band of Indians was moving through the woods to a familiar hunting ground. They traveled for several days through the wild forest. At last they reached the beautiful lake called Kan-ya-ti-yo. It was surrounded by great gray rocks and lofty evergreen trees. Fish were plentiful in the deep, cool lake, and deer came to the shores to drink and rest. Among the trees the squirrels chattered and bears found many kinds of tasty tidbits.

The chief, Hah-yah-no held up his hand, signaling the Indians to halt. He wanted to return thanks to the Great Spirit for their safe journey, and to pray for plenty of game through the winter.

As the pleasant autumn days passed the men and women built the lodges and the children played and danced by the lake. One day while the children were dancing a very old man hobbled up to them. He was like no one they had ever seen before. He was dressed in white feathers and his hair and beard shone like silver in the sun. He scolded the children for playing. He warned that unless they stopped their games and dancing great evil would befall them. The children paid no attention to the old man, even though he warned them many times.

Of course, while the children were playing so actively they became very hungry. They thought how nice it would be if they had some food to eat by the lake when they bacame tired and hungry. So, when the children returned home they asked their parents if they could have food to take with them the next day.

"You will waste the victuals," one said. "You can eat at home as you should," said another--and they were given nothing at all. The children were disappointed, but they went to the lake and danced as before.

Then, one day as they danced, they found themselves being lifted little by little into the air. Their heads were light with hunger. They did not know what was happening, but they were frightened. "Do not look back!" cried one child. A woman picking berries nearby saw them rise. She ran to the camp and called to the parents. They all rushed out offering the children food of every kind, and begging them to return, but they would not. One child looked back, and promptly became a falling star. The others reached the sky, and there they remain to this day, a pretty band of children dancing and sparkling in the heavens.

ORION, A WINTER CONSTELLATION

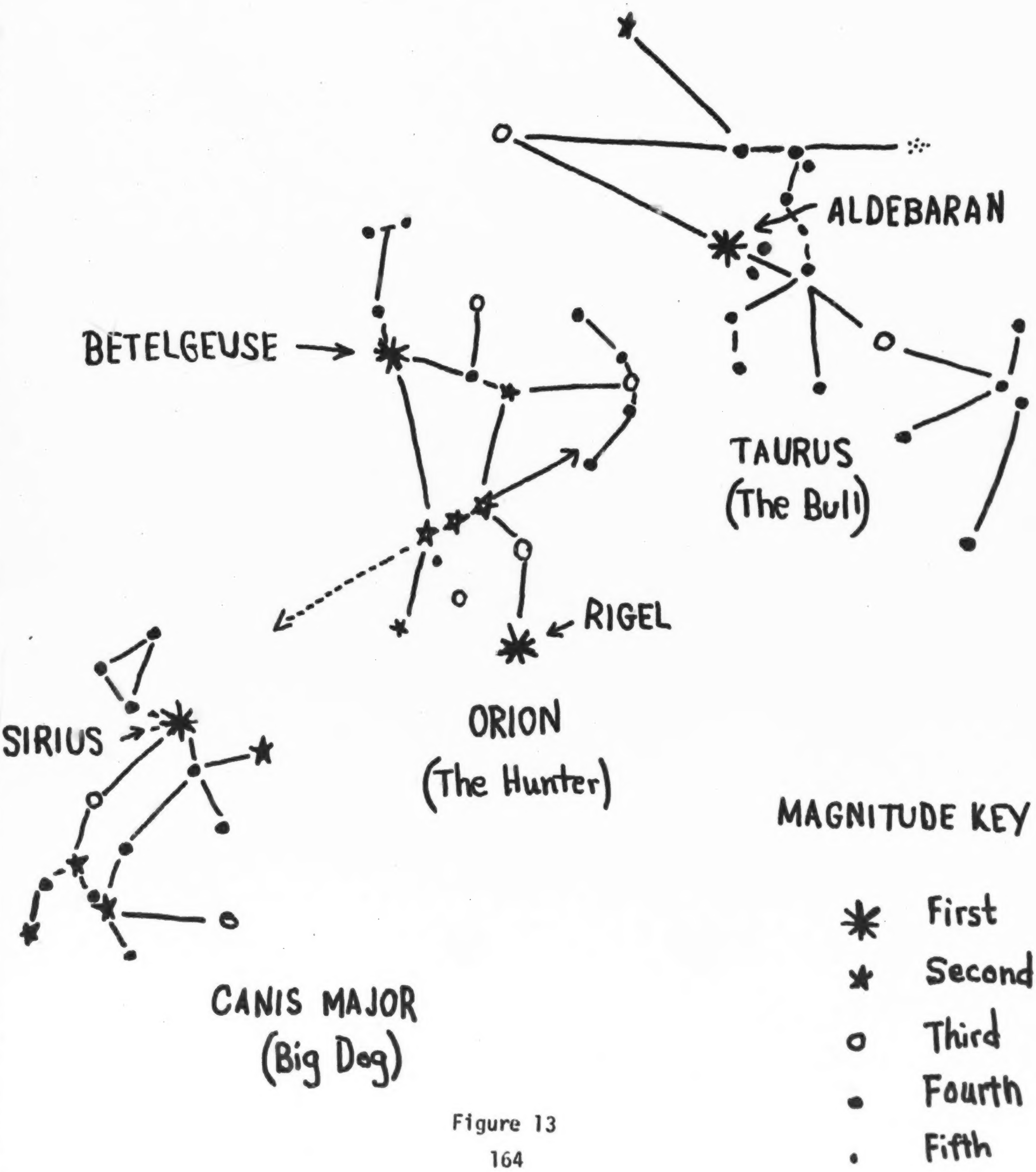

ALDEBARAN
BETELGEUSE
TAURUS
(The Bull)
RIGEL
SIRIUS
ORION
(The Hunter)
MAGNITUDE KEY
First
Second
Third
Fourth
Fifth
CANIS MAJOR
(Big Dog)

Figure 13

LOCATION OF NORTH STAR

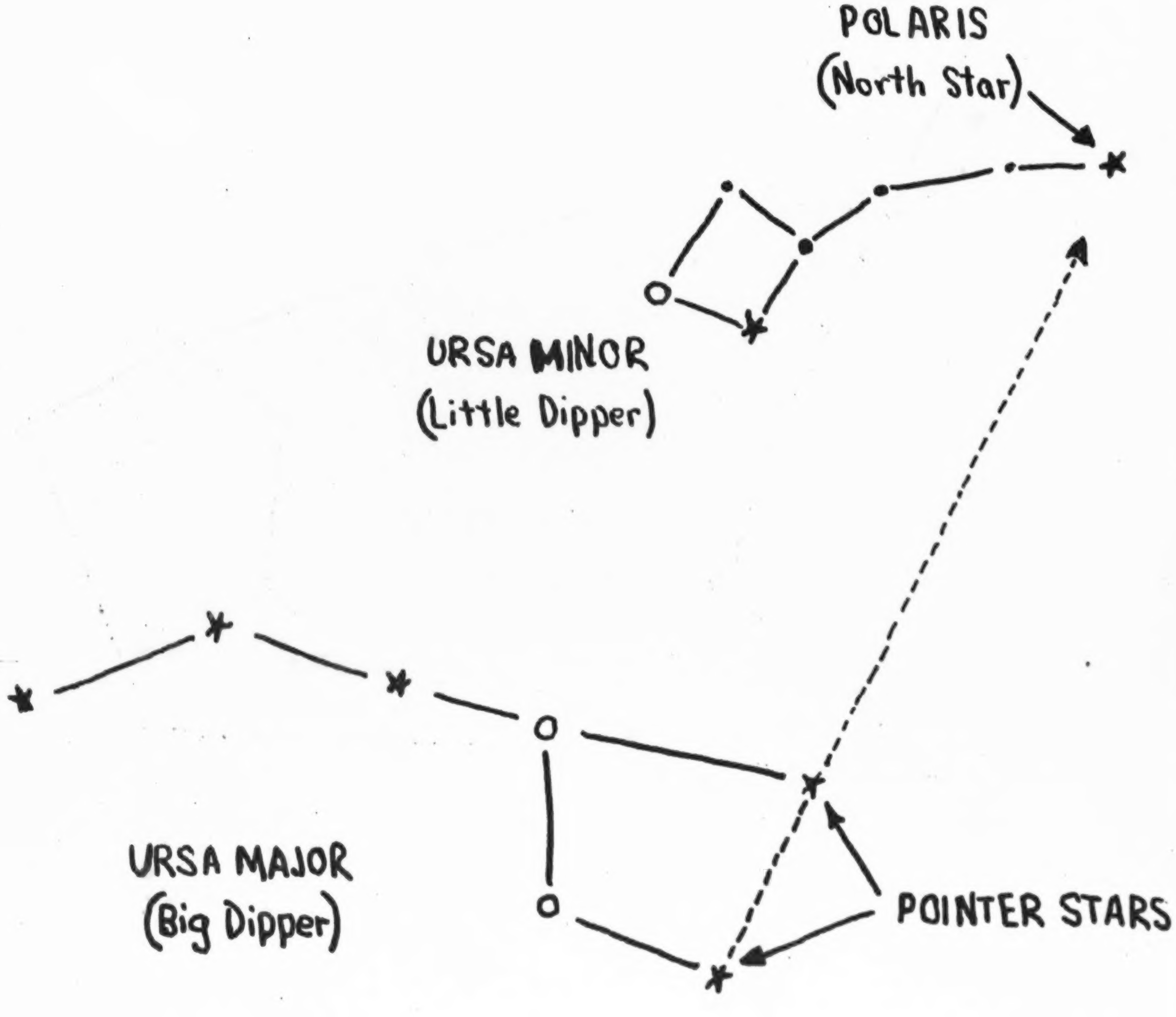

POLARIS
(North Star)
URSA MINOR
(Little Dipper)
URSA MAJOR
(Big Dipper)
POINTER STARS

Figure 14

THE BIG DIPPER
(A Part of the Constellation Ursa Major)

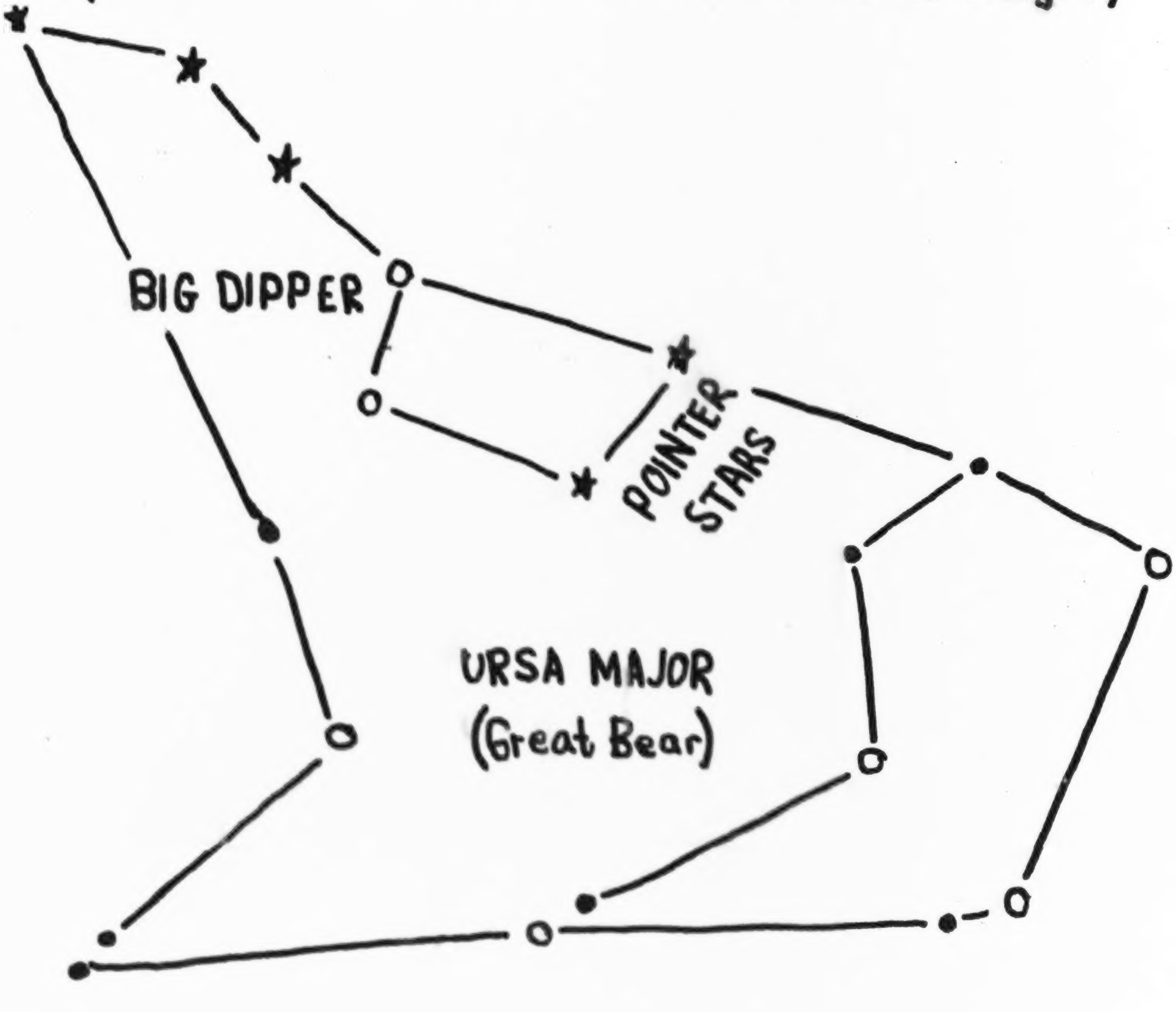

BIG DIPPER
POINTER STARS
URSA MAJOR
(Great Bear)

Figure 15

CEPHEUS, CASSIOPEIA AND CYGNUS

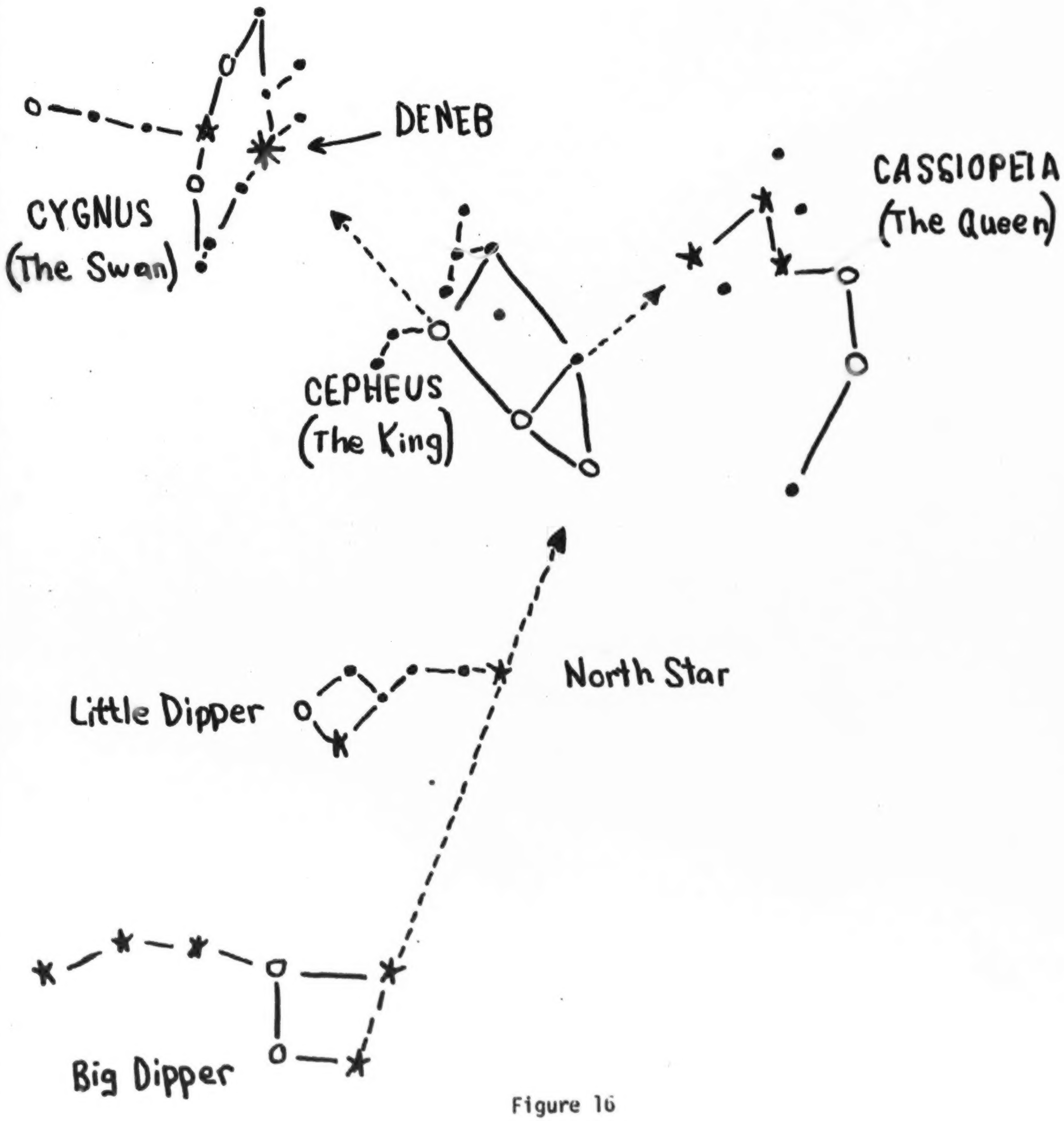

DENEB
CASSIOPEIA
(The Queen)
CYGNUS
(The Swan)
CEPHEUS
(The King)
North Star
Little Dipper
Big Dipper

Figure 16

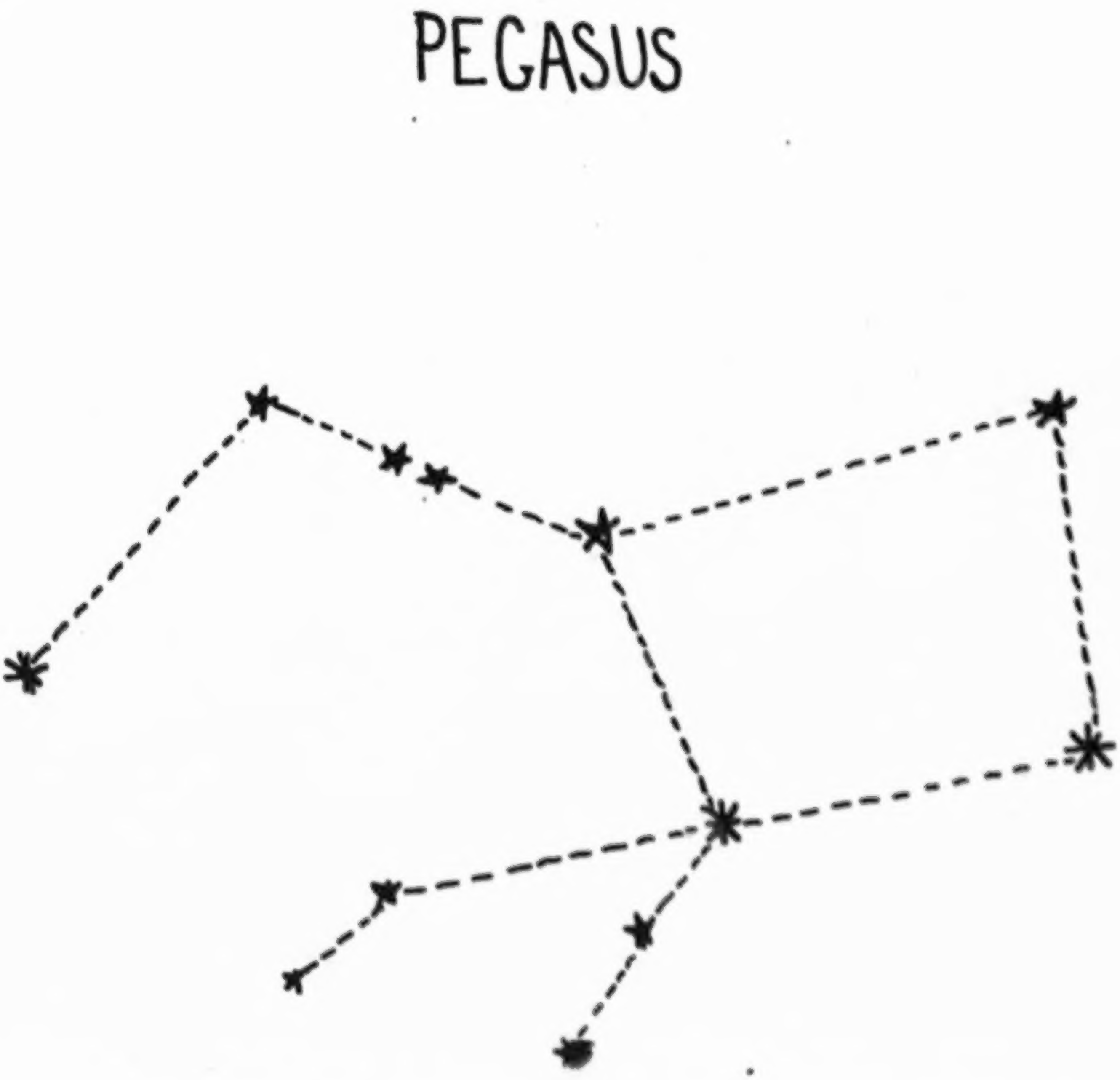


Figure 17

THE DRAGON

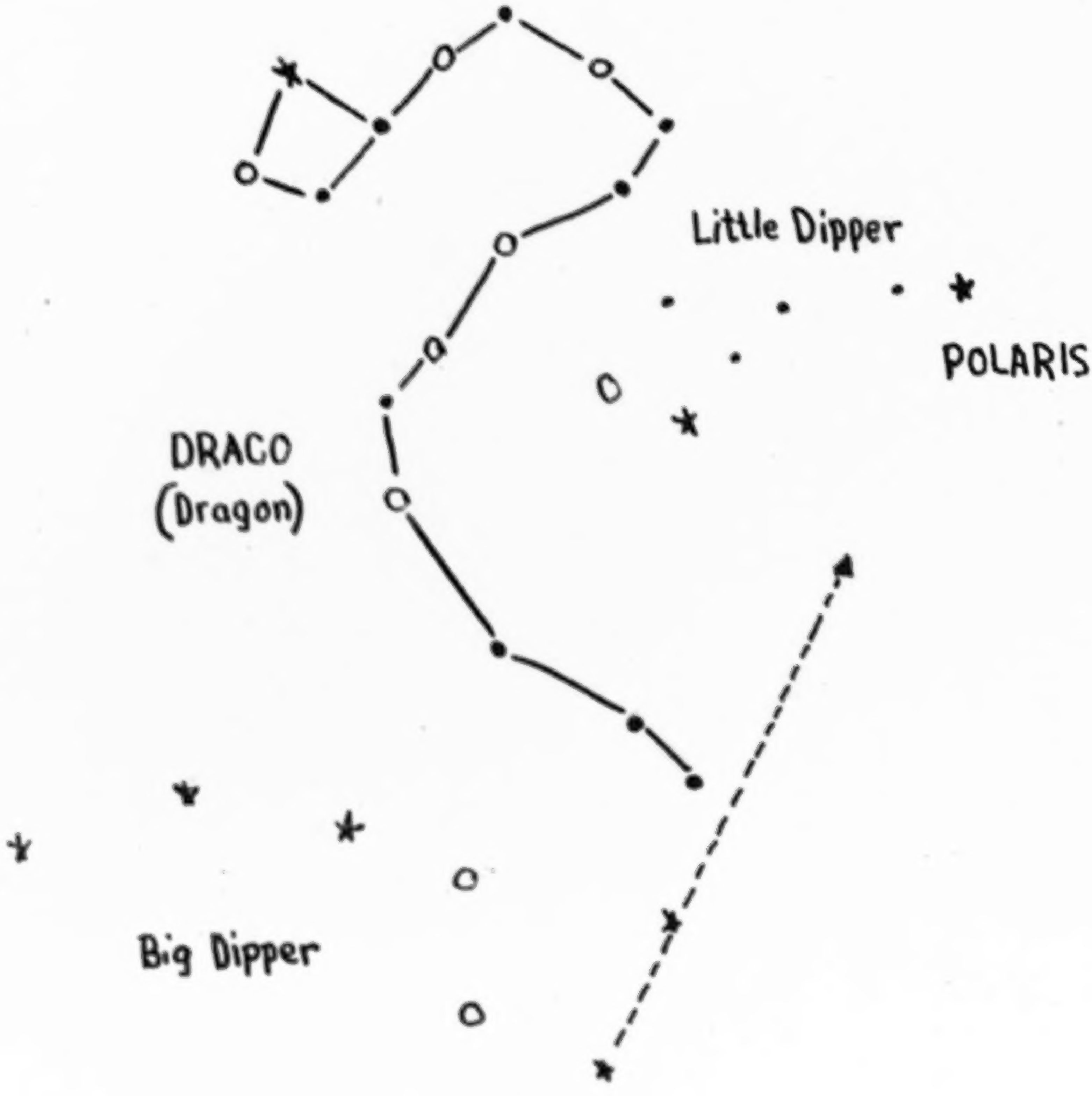

Little Dipper
POLARIS
DRACO
(Dragon)
Big Dipper

Figure 18

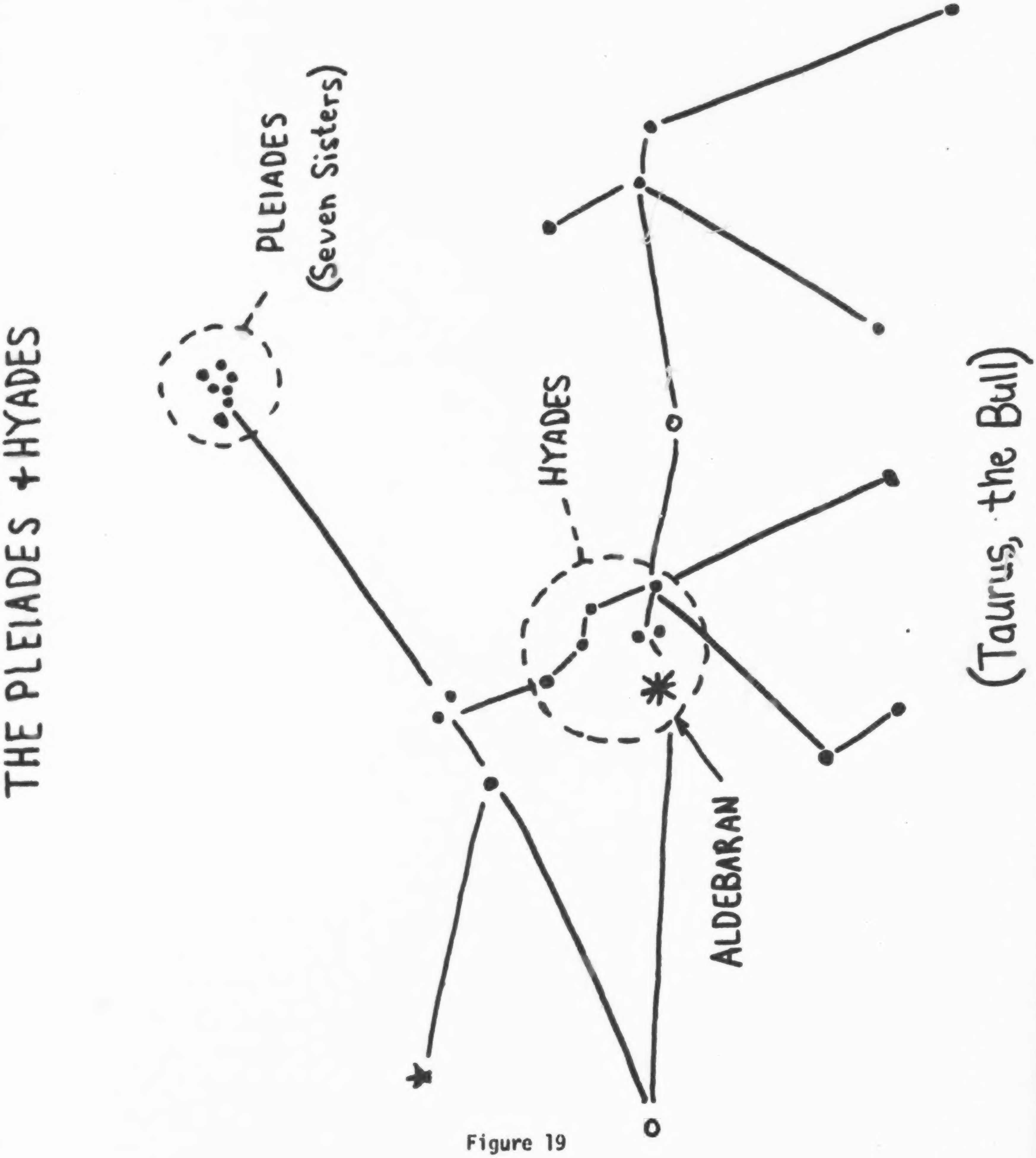

THE PLEIADES + HYADES
PLEIADES
(Seven Sisters)
HYADES
ALDEBARAN
(Taurus, the Bull)

Figure 19

FUTURE SPACE VENTURES

FUTURE SPACE VENTURES

OVERVIEW

Space exploration is one of man's greatest adventures, and the United States, as a world power, must participate with boldness in the exploration of this new frontier. Conquering the strange environment of space is a tremendous challenge to man's ingenuity.

President Lyndon B. Johnson declared, "We expect to explore the moon, not just visit it or photograph it. We plan to explore and chart the planets as well. We shall expand our earth laboratories into space laboratories, and expand our national strength into space dimension."

Will the exploration be worth the cost in lives, in resources, in money? The astronauts are among the first to argue that the risks are great, but the value of space conquest justifies the risks. Every dollar spent on the lunar program goes into buildings, employee payrolls, and training programs. It is a vital part of the national economy. We may find that the moon is not particularly valuable as real estate; however, it probably will be a point from which the solar system can be studied in greater detail. Reaching the moon will be another step toward satisfying man's curiosity about his surroundings.

Man, with his thirst for knowledge and his love of adventure, has braved the dangers of the oceans, the mountains, the deserts, and the air. Now he is ready to meet the challenge of space.

"New Knowledge Needed" would be an appropriate slogan for a bulletin board in every classroom. It is the key to understanding why man is exploring space. Children in America's schools today will find themselves involved in tomorrow's space efforts. Teachers must start cultivating an interest in what is undoubtedly the greatest exploration of all time.

As expressed by John F. Kennedy, the United States' reach for the moon is nothing less than "the most hazardous and dangerous and greatest adventure on which man has ever embarked."

GIVE AND TAKE

Topic

Closed ecological systems

Background

Since space and weight limitations on spacecraft are very severe. it will be impossible to carry enough food and oxygen into space to maintain life on long trips. In order to solve this problem, scientists are working on several new systems which will provide food and oxygen for astronauts. In these closed ecological systems plants will utilize the waste products of the men in order to carry on photosynthesis; the men will use oxygen, the by-product of photosynthesis, for breathing, and will also depend on the plants for food.

Two life-support systems are under study at the present time. One system will utilize algae; and the second will grow plants in hydroponic gardens. Neither system has been perfected because the effect of the space environment on plant growth and survival is not yet fully understood.

The algal system will produce food and oxygen by growing algae in water to provide oxygen and food for the members of the crew in a spacecraft or space station. The algae may be consumed by the crew, or used to feed small insects or fish which in turn, would be eaten by the crew. It has been predicted that a very light, compact algal system eventually can be developed.

The hydroponic system is similar to the algal except that higher forms of plant life will be grown. Hydroponics is the process of growing plants in water which has been enriched with the proper plant nutrients. This process has several advantages over the algal system because the requirements for environmental control probably will be less critical. It will require less complex equipment, and the food products will be more palatable.

Vocabulary

algae
algal system
carbon dioxide
ecological
extraterrestrial
geotropism
hydroponics
life-support
metabolic
metabolism
nutrient
osmosis
palatable
photosynthesis
regeneration
stomates

Suggested Activities

a. To show the effects of depriving a green plant of carbon dioxide, carefully cover the top side of a healthy leaf with vaseline.

Then cover the underside of another leaf with vaseline. After one week examine the leaves. The one covered on the underside will have died because vaseline clogged the stomates (or openings) preventing intake of water and carbon dioxide. The leaf covered on the top side will be living because the stomates on the underside remain intact.

b. To show that green plants seek light, place a small sweet potato in one half glass of water and put it in the sunlight. When the potato begins to sprout small green vines, place the glass and potato in a shoe box fitted inside with cardboard baffles. The shoe box should have a hole in one end. The baffles can be attached by means of cellophane tape. Attach a baffle to each side of the box. Cover the box and place it in the sunlight with the hole facing the sun. As the vine grows it will move around the baffles toward the light.

c. You can demonstrate geotropism by placing a blotter around the inside of a drinking glass and securing it to the glass with cellophane tape. Place a few radish or lima bean seeds between the blotter and the glass. Keep the blotter moist throughout the experiment. The seeds should sprout in a few days. When the stems and leaves are visible, turn the glass upside down and observe what happens. The plant will continue to grow but the roots will turn downward, due to the pull of gravity.

d. Make algae cookies.
Recipe:

4 tablespoons concentrated chlorella (algae)
2 cups flour
½ tablespoon salt
4 tablespoons shortening
3/4 cup milk
3 tablespoons baking powder.

Cream shortening. Add dry ingredients and milk. Roll out in ½-inch sheets. Spread with mixture of sugar, cinnamon and butter. Roll up a slice into pinwheels. Bake at 350° for 10 to 15 minutes.

Chlorella or algae can be obtained from various biological supply houses or write to:

Carolina Biological Supply Company
Burlington, North Carolina

e. Closed ecological complex study

The operation of a closed environment can be demonstrated using a sealed balanced aquarium. This experiment will provide understandings of the problems in maintaining life in outer space.

Discuss the requirements that are necessary to sustain life on earth (food, water, oxygen, proper temperature, gravity, shelter, etc.).

Discuss the dependency of animals on plants, and plants on animals.

Make a balanced aquarium.

You will need (for each child) a quart jar with a screw top lid; large grained sand that has been washed to remove the dirt and dust; thermometer; one small goldfish or guppy; two sprigs of Elodea (an aquarium plant); two nails; dechlorinated water to fill the jar 3/4 full. (Let tap water sit in a large container overnight to dechlorinate). To oxygenate, stir the water vigorously before using.

On the first day ask children to bring their jars. Compare them to a space capsule. In the bottom of the clean jar place about one inch of rinsed sand and fill the jar about 3/4 full of water. Let each child plant two sprigs of Elodea and leave it undisturbed overnight.

The next day place a fish and two snails in the jar. Measure the temperature of the water with a thermometer and again leave it overnight with the jar uncovered to establish a balance between snails, fish, and plants.

On the following day note the temperature and put the lid securely on the jar. Place in indirect sunlight. After placing the lid on the jar, do not open. If a balance between plant and animals has been reached, the animals and plants may live for months with no further care. If breathing of the animals looks laborious, open the jar and place a small amount of food in the closed system. When opening the jar, the closed environment is terminated.

Compare the conditions of a balanced aquarium to those of a space capsule designed for long trips.

Notice the oxygen bubbles being given off by the green plants (through photosynthetic activity) and note activities of the fish and snails.

Record the observations on a data sheet:

DAY	TIME	TEMPERATURE	ACTIVITY OF FISH	ACTIVITY OF SNAILS	APPEARANCE OF AQUARIUM

Questions related to balanced acquarium activity

1. What does the plant provide for the animal?
2. What does the animal provide for the plant?
3. What is the function of the snail?
4. Why did we seal the jar?
5. What kinds of food will an astronaut take into space?
6. How will the astronaut be provided with oxygen?
7. How will human waste materials be utilized?
8. Is there a relationship between the size of the animal and the amount of green plant life necessary to maintain a balance?
9. What would happen if the fish were to eat all of the green plants?
10. What would happen to the plant and the snail if the fish were to die?
11. Why did some aquariums last longer than others?

f. Hydroponic gardens

1. Make a solution "A" by dissolving 2 teaspoons of calcium nitrate, ½ tsp. of potassium acid phosphate, 1¼ tsp. Epsom salts, and ¼ tsp. of ammonium sulfate into a cup of water. Pour this solution into 2½ gallons of distilled water.
2. Make solution "B" by dissolving 1/8 tsp. of each of the following materials into a cup of water: zinc sulfate, manganese sulfate, and boric acid.
3. Make solution "C" by dissolving 1/8 tsp. of ferrous sulfate into a cup of water. Now add one teaspoon of solution B and 3 tablespoons of solution C to solution A.
4. Secure a large aquarium or similar container. Take a piece of wire mesh the same width, but several inches longer than the inside dimensions of the container. Bend the ends of the mesh downward and insert it so that it forms a table a few inches above the floor of the container.

5. Pour the mixture into the aquarium to the level of the wire. Scatter spiagnum moss over the wire table. The moss serves only to hold the seeds.

6. Place the corn and bean seeds (or whatever seeds you desire) on the top of the moss. The seeds will germinate, roots growing down into the solution. Continue to maintain the level of the solution throughout the growing period.

7. Keep a record of each seed's germination and growth. The class could plant a control garden in soil and compare the two, but be sure the light and warmth is the same for both gardens.

Source Materials

Books

Crosby, Alexander L., and Larrick, Nancy, Rockets Into Space, New York: Random House, 1959 p. i.
Henry, James P., Biomedical Aspects of Space Flight, New York: Holt, Rinehart and Winston, Inc., 1966 t
Hyde, Margaret O. Off Into Space, New York: McGraw-Hill, 1959 t
Lent, Henry, Man Alive in Outer Space, New York: MacMillan Co., 1961 i. t.
Viorst, Judith, Projects: Space, New York: Washington Square Press, Inc., 1962 t
Wells, Robert, Alive in Space, New York: Little, Brown Co., 1961 i. t.

Films

A Case for Regeneration, Part I in series, Living in Space, 12 min. sound, color, 1965, NASA 16mm.
Osmosis, 16 min., color, University of Nebraska Film Library
Plants Make Food, 1 reel, b/w, i. t. Churchill Wexler Company

SKY STOPS

Topic

Space stations

Background

Just as the air age created the need for airports, the age of space travel will require the establishment of manned stations in space. These stations will be used as centers for many kinds of research. They also will serve as launch platforms for interplanetary spacecraft.

In the early 1960's the United States Air Force initiated work on America's first space station, named MOL (Manned Orbiting Laboratory). One of the primary purposes of the MOL experiment will be to determine the effect of long space missions (up to 30 days) on man's body and spirit. MOL astronauts will live and work in a can-like container ten feet in diameter and forty-one feet long. The MOL, in orbit about two hundred sixty miles above the earth, will be a simple two to four-man test laboratory that will have an orbital life of less than a year. This space station will have a small centrifuge on board which will be used to create artificial gravity for the crew members so that they will not live in a zero-g environment for extended periods of time.

A more advanced space station, designated MORL (Manned Orbiting Research Laboratory), is now in the planning stages. This station will weigh 35 thousand pounds and will sustain a crew in space for six to twelve months. The LORL (Large Orbiting Research Laboratory), a more advanced space station, is also being developed. It will be designed to house crews of twenty-four to twenty-six people.

Douglas Aircraft Company has designed a "spaceball" concept for a space station that will be of immense proportions. This type of station will be built from burned out Saturn-IVB propellant tanks. These tanks will be connected in clusters and converted into living quarters, work areas, recreational facilities and research centers. The Marshall Space Flight Center will design and build the MDA (Multiple Docking Adapter) which will be attached to the Douglas "Spaceball". The MDA will allow five payloads to be joined together in orbit.

Scientists have proposed several designs for space stations of the future. Dr. von Braun has designed a doughnut-shaped station that would spin to provide artificial gravity in space. The men in the station would work and live in the hub of the station and on the outside walls. Other proposed configurations for space stations include pinwheel designs, butterfly designs, dumbbell, tubular, and cylindrical shapes. Space stations of the future will be used to construct and service space ships and to relay scientific data back to earth.

Vocabulary

- artificial environment
- artificial gravity
- astronomical
- biological
- boosters
- centrifuge
- meteorological
- observatory
- orbit
- radiation
- thrust
- velocity
- weightlessness
- zero-g

Suggestions

A partial list of materials to have on hand for the construction of an imaginary space station are: plastic bottles, mailing tubes, oatmeal boxes, egg cartons, string, pins, pipe cleaners, wire, glue, tape, etc. Tools such as a jigsaw, hammer, knife, paper punch, and scissors should also be on hand. The space station could be made to spin through the use of a lazy susan or a fishing swivel.

Suggested Activities

a. Have children draw or paint an imaginary space station.

b. Collect clippings and information concerning the development of space stations.

c. Construct a model space station.

d. Have a creative writing lesson in which the students describe things they might see from a space station. Encourage the use of descriptive language.

e. "Space Structures" could be made from wire, papier mache, or styrofoam.

Source Materials

Books

Bergaust, Eric, Space Stations, New York: Putnam's Sons, 1962 i
Clarke, Arthur C., The Exploration of Space, Greenwich, Conn.: Fawcett Pub. Inc., 1951
Cox, Donald, Stations in Space, New York: Holt, Rinehart & Winston, Inc., 1960 i. t.
Dietz, David, All About Satellites and Space Ships, New York: Random House, 1962 i
Ley, Willy, Harnessing Space, New York: MacMillan Co., 1963 t
Ley, Willy, Space Stations, Washington, D. C.: Golden Press, 1958 i
Stambler, Irwin, Orbiting Stations, New York: Putnam's Sons, 1965 i. t.

Films

Earth Satellites: Explorers of Outer Space, 17 min., color, University of Nebraska Catalog i. t.
First Men into Space-Solving the Space Survival Problems, 16 min., color, University of Nebraska Catalog i. t.
Mars and Beyond, 30 min., color, Walt Disney
Way Stations in Space, 13 min., b/w, NASA

Filmstrips

Spacecraft Sends News About Mars, color, Weekly Reader
What are Space Stations, 41 frames, color, from set 1090, Jam Handy Company

Transparencies

Space Age Science Series; *Typical Space Station*, Projecto Aid No. 258-559

OPEN HOUSE IN SPACE

Topic

Bases on celestial bodies

Background

When the exploration of interplanetary space begins, space colonies probably will be established on the moon and in space. These bases will be research centers and refueling stops for spacecraft. The construction of a space colony on the moon is already being planned.

One of the most difficult problems in building these colonies is that each pound of building material or tools used in their construction requires thousands of pounds of fuel to put it into space. It will cost thousands of dollars to carry each piece of equipment into space. For this reason the first moon base will probably be built of hardware left over from earlier space flights. The empty fuel tanks and burned out stages of rockets probably will be utilized for improvised shelters on the moon. As time progresses and less costly means of transporting cargo to the celestial bodies are found, a more elaborate base will be constructed from materials brought from earth.

A new, light-weight instant moon shelter is now being developed for future use in space colonies. It will be prefabricated from fiberglass cloth impregnated with gelatin and sealed in airtight containers. On the moon the containers will be opened and the shelters unfolded. As the water evaporates from the gelatin, the shelters will harden into rigid structures.

Vocabulary

atmosphere
celestial
evaporated
gelatin
gravitational pull
impregnated
meteors
prefabricated
radiation
space base
vacuum

Suggested Activities

a. The project of building a space base can be used as a class endeavor or as a small-group activity. This activity is an opportunity for releasing children's creativity. Discuss with the children the problems that man will meet in space, for example: radiation, procurement of water and food, meteors, and temperature extremes. Let the pupils design equipment for use in space. A variety of materials will be essential in order that the children can create a simulated moon surface, buildings, equipment and all the items connected with the base.

Some suggested materials are: clay, paint, cloth, yarn, paper, boxes, saran wrap, toothpicks, sand, cotton, wood, and popsicle-sticks, wire and wire mesh, screening, plastic covers on packaged toys or other readily available materials.

Soak cloth in wallpaper paste and drape it over wires or other forms. When it is dry it will be firm and easily painted. Provide a variety of books so the children can read about some of the present concepts of space bases.

b. Design a space colony on paper.

c. Draw pictures of special construction equipment (tractors, scoops, trucks, etc.), as well as vehicles that would transport men and cargo from base to base on the moon.

d. Pretend to be living in a space station and write letters to friends or family telling about the day-to-day activities.

e. Hold an imaginary press conference with recent returnees from a space colony. Have some of the reporters write articles for the class or school paper and others conduct a television news report.

Source Materials

Books

Branley, Franklin M., *Exploration of the Moon*, Garden City, New York: The Natural History Press, 1964 i. t.
Halvary, T. C., *Moon Base-Technical and Psychological Aspects*, New York: John F. Rider Publishing Co., 1960 t.
MacGregor, Ellen, *Miss Pickerell on the Moon*, New York: McGraw-Hill, 1965 i.
Nephew, William and Chester, Michael, *Moon Base*, New York: Putnam's Sons, 1959 p. i.
Nephew, William and Chester, Michael, *Moon Trip*, New York: Putnam's Sons, 1959 p. i.

Filmstrip

Stations on the Moon, color, 38 frames, Eye Gate House, Inc., Jamaica, New York, 11435

Film

Trip to the Moon, 18 min., color, University of Nebraska catalogue

DESTINATION SPACE

Topic

Space station communities

Background

As children develop an understanding of and appreciation for the workers in their community and the services they render, they may also recognize the need to employ trained personnel for similar services in a space station. Children can appreciate the fact that in order for a community to function and make contributions, an interdependence must exist among the people.

The activities and the number of people living in the space stations will depend on the size of the stations. In the early relatively small colonies (MOL, MORL AND LORL) where space will be limited, the crew's activities will be rather restricted. The men will be performing various tasks necessary to find out about their new environment, and to determine the effects that living in space will have on the human body. Since work in this limited area will not provide sufficient exercise for the men, isometric and isotonic exercises will be used to keep them physically fit. In isometric exercises, the muscles are strengthened by pulling or pushing against stationary objects. Muscles are also used to pull against each other. In isotonic exercises, the person exercises his muscles by moving, lifting, pulling, pushing or stretching objects which are designed for muscle building. This means that special equipment will be required. Recreation will also be a big problem in space stations, because the men will be subjected to confinement for long periods of time during which they will be dependent on their own resources for diversion.

In the more advanced space stations, life, as scientists envision it, will be very exciting. In these larger space stations, scientists of all kinds will be at work. Geologists will study the earth from space; meterologists will observe weather patterns; astronomers will be able to study celestial bodies without viewing them through a distorting haze. Chemists will search for new elements and learn more about the properties of space. Physicists will be involved with studies of physical processes and phenomena of outer space, and biologists will be studying life in a zero-g environment.

In the medical centers which may be on these future space stations, doctors and nurses may be caring for patients suffering from diseases that can be cured in space. Arthritic patients, for example, may be cured by a stay in a space hospital. The decalcification of bones that takes place under zero-g conditions may cure arthritis.

In the service station of the space colony of the future, astronaut mechanics will be repairing and refueling ships on missions in interplanetary space.

The farmers of the space stations will be busy tending hydroponic gardens which will provide food and oxygen for the colony. There probably will be custodians, photographers, navigators and other workers on the space stations.

Every effort will be made to make the stations pleasant places to live. There will be moving pictures and libraries on board. There also will be chess games, card games and other indoor sports available to provide a relatively normal life in outer space.

Vocabulary

arthritis
astronomer
biologist
chemist
decalcification
geologist
hydroponics
isometrics
isotonics
LORL (Large Orbiting Laboratory)
MOL (Manned Orbiting Laboratory)
MORL (Manned Orbiting Research Laboratory)
meteorologist
microfilm
phenomena
physicist
zero-g

Suggested Activities

a. Plan a program of recreation for space travelers that would involve morning exercises, late afternoon activities, and an evening recreation program.

b. Make a study of isotonic and isometric exercises, how they originated and how each type affects the muscles of the human body. Resource people might be used to give information.

c. Devise your own isometric and isotonic exercises that might be used in a small closet or simulated space ship. Paired exercises should be closely supervised to prevent accidents.

d. Invent some new games that could be played in space stations at zero-g conditions which would provide some mental diversion for the space men.

e. Construct a space station. Boxes or blocks may be used.

f. The children can take turns portraying the activities of the workers in a space station.

g. Puppets provide an interesting way to help children discuss and review what they know about conditions in space. The puppeteers should be concealed behind a table draped with a cloth. A member of the class asks a question of a puppeteer.

The puppet appears if he can answer the question; if not, he should have a chance to answer a second question. Another child could answer the first question.

h. Draw pictures illustrating the different activities of a space station's crew. Write stories about the pictures. Children can tell how the work in a space station compares to work on earth.

i. Make an instructional bulletin board depicting the workers on a space station and how their jobs are related to work done by persons in the same profession on Earth.

j. Write a story telling about living in outer space.

Source Materials

Books

Binder, Otto O., Victory in Space, New York: Walker & Co., 1962 t
Clarke, Arthur C., Space Research and Exploration, New York: William Sloane Assoc., 1958 t
Clarke, Arthur C., The Exploration of Space, New York: Harper and Brothers, 1959 t
Hyde, Margaret O., Off Into Space, New York: McGraw Hill, 1959 t
Worst, Judith, Projects: Space, New York: Washington Square Press, 1962 t

APPENDIX

ATMOSPHERE

Northern Lights

My father took me up from bed
  And out into the night
To see the wide Canadian sky
  Alive with lines of light.

The autumn lawn was cold with dew,
  The garden dark and still,
As all those fingers made of fire
  Reached up beyond the hill.

The moon had gone away that night
  Behind the blacksmith shop.
The Milky Way looked pale and far,
  Above the chimney top.

And such a lot of prickly stars
  Were winking at me when
My father took me back to bed
  To fall asleep again.

Marion Edey

The Rainbow

I saw the lovely arch
Of Rainbow span the sky,
The gold sun burning
As the rain swept by.

In bright-ringed solitude
The showery foliage shone
One lovely moment,
And the Bow was gone.

Walter de la Mare

The Rainbow

Boats sail on the rivers,
  And ships sail on the seas;
But clouds that sail across the sky
  Are prettier far than these.

There are bridges on the rivers,
  As pretty as you please,
But the bow that bridges heaven,
  And overtops the trees,
And builds a road from earth to sky,
  Is prettier far than these.

Christina Rossetti

Rainbow

How gray the rain
And gray the world
And gray the rain clouds overhead,
When suddenly
Some cloud is furled
And there's gleaming sun instead!

The raindrops drip,
Prismatic light,
And trees and meadows burn in green,
And arched in air,
Serene and bright
The rainbow all at once is seen.

Serene and bright
The rainbow stands
That was not anywhere before,
And so may joy
Fill empty hands
When someone enters through a door.

Elizabeth Coatsworth

CLOUDS

The Cloud

I bring fresh showers for the thirsting flowers,
   From the seas and the streams;
I bear light shade for the leaves when laid
   In their noonday dreams.
From my wings are shaken the dews that waken
   The sweet buds every one,
When rocked to rest on their mother's breast,
   As she dances about the sun.
I wield the flail of the lashing hail,
   And whiten the green plains under;
And then again i dissolve it in rain,
   And laugh as I pass in thunder.

Percy Bysshe Shelley

Rolling Clouds

Wool white horses and their heads sag and roll,
Snow white sheep and their tails drag far,
Impossible animals ever more impossible-
   They walk on the sky to say How do you do?
     Or Good-by or Back-soon-maybe.

Or would you say any white flowers come
   more lovely than certain white clouds?
Or would you say any tall mountains beckon,
   rise and beckon beyond certain tall walking clouds?

Is there any roll of white sea-horses equal to
   the sky-horse white of certain clouds rolling?

Carl Sandburg

Fog in the Park

The fog's a fuzzy caterpillar
Crawling through the park.
It creeps and crawls on everything
And turns the day to dark.
It makes the bright and shining sun
As pale as any moon
And all around the quiet trees
It spins a gray cocoon.

Rowena Bennett

The Clouds

Oh, clouds so high, soft, and fleecy
All piled up there against the blue,
I'd like to go up there and touch you
And see if you're real-made of dew.

Sometimes you're white like the snowdrift.
Sometimes you're blue like the skies.
Sometimes you're colored like rainbows,
Some large, some small - every size.

Sometimes you're black, swift, and angry,
'Tis then you send lightning and hail,
But lo! on your breast is a rainbow,
God's promise that never can fail.

You send the rain for the flowers
Or snow that shields them from cold.
I would fain know the secret
Of the wonder and magic you hold.

Mrs. Louis Nadeau

The Cloud Horse

A little old man lived up in a cloud,
And he was as poor as he was proud.

When the sun came out, and the day was bright,
His dear little house was all shining white.

When evening came, and the sun went to bed,
His dear little house turned a lovely red.

When the stars came out, and they winked at him,
His dear little house was all grey and dim.

When the moon came out, shining soft and clear,
His dear little house looked ever so dear!

But the sun was so hot one very fine day
That the cloud and the little man melted away!
And where they melted to - no one can say!

Adrian Mott

Hide and Seek

Clouds are hiding from a breeze
That looks and listens among the trees

And seeks in vines along a wall,
Then over a meadow it calls the call:

I see a cloud! all-ee-outs-in-free!
But all it sees is a blossoming tree,

So the breeze, too lonely and tired to play,
Lies down in the sun and sleeps all day

While the clouds, still hiding white and still,
Wait and wait behind a hill.

The Cloud-mobile

Above my face is a map.
Continents form and fade.
Blue countries, made
On a white sea, are erased,
and white countries traced
on a blue sea.

It is a map that moves,
faster than real,
but so slow.
Only my watching proves
that island has being,
or that bay.

It is a model of time.
Mountains are wearing away,
coasts cracking,
the ocean spills over,
then hills
heap into view
with river-cuts of blue
between them.

It is a map of change,
This is the way things are
with a stone or a star.
This is the way things go,
hard or soft,
swift or slow.

May Swenson

HEAVENLY BODIES

The Motion of the Earth

A day with sky so wide,
So stripped of cloud, so scrubbed, so vacuumed free
Of dust, that you can see
The earth-line as a curve, can watch the blue
Wrap over the edge, looping round and under,
Making you wonder
Whether the dark has anywhere left to hide.
But the world is slipping away; the polished sky
Gives nothing to grip on; clicked from the knuckle
The marble rolls along the gutter of time--
Earth, star and galaxy
Shifting their place in space.
Noon, sunset, clouds, the equable verying weather,
The diffused light, the illusion of blue,
Conceal each hour a different constellation.
All things are new
Over the sun, but we,
Our eyes on our shoes, go staring
At the asphalt, the gravel, the grass at the roadside,
   the doorstep, the doddles of snails, the crochet of
   mortar and lime,
Seeing the seeming familiar, though every stride
Takes us a thousand miles from where we were before.

Norman Nicholson

Moonbeam

Moonbeam steps the silken ladder
Woven by Mrs. Spider
To ask her to spin him a net
To catch the stars.

Hilda Conkling

Autumn Dusk

I saw above a sea of hills
   A solitary planet shine,
And there was no one near or far
   To keep the world from being mine.

Sara Teasdale

Question

Do you ever see the moon
When you play at noon?
Can you see a star
When it is very far?
Or do you just say,
"It is too far away"?

Sherry Corter

As Ocean Holds the Globe

As ocean holds the globe in its embrace,
So dreams about our earthly life are sweeping;
Night comes, and the sonorous billows chase
Each other, on the coast of darkness leaping.

That voice of dream, how urgently it sounds!
Alert, the magic skiff prepares to wander;
The tide swells swiftly, now the white sail rounds,
And we are borne to shoreless waters yonder.

Lo, the high heavens, starred and luminous,
Mysteriously from the deeps are gazing,
And we sail onward, while surrounding us
On every side the strange abyss is blazing.

Babette Deutsch

Riddle #29: The Moon and the Sun

I saw a silvery creature scurrying
Home, as lovely and light as heaven
Itself, running with stolen treasure
Between its horns. It hoped, by deceit
And daring and art, to set an arbor
There in that soaring castle. Then
A shining creature, known to everyone
On earth, climbed the mountains and cliffs,
Rescued his prize, and drove the wily
Imposter back to darkness. It fled
To the west, swearing revenge. The morning
Dust scattered away, dew
Fell, and the night was gone. And no one
Knew where the soft-footed thief had vanished.

Translated by Burton Raffel

Measure Me, Sky

Measure me, sky!
   Tell me I reach by a song
Nearer the stars:
   I have been little so long.

Weigh me, high wind!
   What will your wild scales record?
Profit by pain,
   Joy by the weight of a word.

Horizon, reach out,
   Catch at my hands, stretch me taut,
Rim of the world!
   Widen my eyes by a thought.

Sky, be my depth,
   Wind, be my tolerant height,
World, my heart's span -
   Loneliness, wings for my flight!

Lenora Speyer

I Stood upon a Star

I stretched my mind until I stood
   Out in space, upon a star;
I looked, and saw the flying earth
   Where seven planets are.

Delicately interweaving
   Like fireflies on a moist June night,
The planetoids among the planets
   Played for their own delight.

I watched earth putting off her winter
   And slipping into green;
I saw the dark side of the moon
   No man has ever seen.

Like shining wheels in an opened watch
   They all revolved with soundless motion;
Earth sparkled like a rain-wet flower,
   Bearing her petals, plain and ocean.

Sara Teasdale

Rune of Riches

I have a golden ball,
A big, bright, shining one,
Pure gold; and it is all
Mine. - It is the sun.

I have a silver ball,
A white and glistening stone
That other people call
The moon; - my very own!

The jewel things that prick
My cushion's soft blue cover
Are mine, - my stars, thick, thick,
Scattered the sky all over.

Florence Converse

So Many Nights

So many nights...
Blue nights,
Brown nights,
And the sudden lights
In deep black nights
Of stars,
And cars,
And airplanes,
And soft gray nights when it rains,
And blue nights with a foggy moon
Smoking in the trees...
And pink and red nights
Above great cities,
And silver nights all filled with stars,
And misty nights when a white mist
Drifts
And lifts over the white-topped fields,
And purple nights beyond the lights
Of your own room,
And blue snowy nights,
And night that is just
Dark bright night.

Margaret Wise Brown

Questions at Night

Why
Is the sky?

What starts the thunder overhead?
Who makes the crashing noise?
Are the angels falling out of beds?
Are they breaking all their toys?

Why does the sun go down so soon?
Why do the night-clouds crawl
Hungrily up to the new-laid moon
And swallow it, shell and all?

If there's a Bear among the stars,
As all the people say,
Won't he jump over those Pasture-bars
And drink up the Milky Way?

Does every star that happens to fall
Turn into a fire-fly?
Can't it ever get back to Heaven at all?
And why
Is the sky?

Louis Untermeyer

Wise

Whoever planned
the world was wise
to think of land
and seas and skies,

To plan a sun
and moon that could
be made to run
the way they should.

But how did He
have time for all
the things we see
that are so small -

Like flowers in parks
and flakes of snow
and little sparks
the fireflies show?

Aileen Fisher

Moon Song

There is a star that runs very fast,
That goes pulling the moon
Through the tops of the poplars.
It is all in silver,
The tall star:
The moon rolls goldenly along
Out of breath --
Mr. Moon, does he make you hurry?

Hilda Conkling

Last Song

To the sun
Who has shone
   All day,
To the moon
Who has gone
   Away,
To the milk-white,
Silk-white,
Lily-white Star
A fond goodnight
Wherever you are.

James Guthrie

Will Ever?

Will he ever be weary of wandering,
   The flaming sun?
Ever weary of waning in lovelight,
   The white still moon?
Will ever a shepherd come
   With a crook of simple gold,
And lead all the little stars
   Like lambs to the fold?

Will ever the Wanderer sail
   From over the sea,
Up the river of water,
   To the stones to me?
Will he take us all into his ship,
   Dreaming and waft us far,
To where in the clouds of the West
   The islands are?

Walter de la Mare

Wanderers

Wide are the meadows of night,
And daisies are shining there,
Tossing their lovely dews
Lustrous and fair:
And through these sweet fields go,
Wand'ers 'mind the stars -
Venus, Mercury, Uranus, Neptune,
Saturn, Jupiter, Mars.

Tired in their silver, they move,
And circling, whisper and say,
Fair are the blossoming meads of delight
Through which we stray.

Walter de la Mare

Very Early

When I wake in the early mist
The sun has hardly shown
And everything is still asleep
And I'm awake alone.
The stars are faint and flickering.
The sun is new and shy.
And all the world sleeps quietly,
Except the sun and I.
And then beginning noises start,
The whirls and huffs and hums,
The birds peep out to find a worm,
The mice squeak out for crumbs,
The calf moos out to find the cow,
And taste the morning air
And everything is wide awake
And running everywhere.
The dew has dried,
The fields are warm,
The day is loud and bright,
And I'm the one who woke the sun
And kissed the stars good night.

Arla Kuskin

MOON

The Moon

I like to sit on our doorsill,
And watch the place above the hill
Get lighter every minute till
The moon comes up all bright and still.

Sometimes he is so slow I think
He'll never come: Then, in a wink
Almost behind the big oak tree,
He pops right up, and smiles at me.

May Morgan

Silver

Slowly, silently, now the moon
Walks the night in her silver shoon;
This way, and that, she peers, and sees
Silver fruit upon the silver trees;
One by one the casements catch
Her beams beneath the silvery thatch;
Couched in his kennel, like a log,
With paws of silver sleeps the dog;
From their shadowy cote the white breasts peep
Of doves in a silver-feathered sleep;
A harvest mouse goes scampering by,
With silver claws, and silver eye;
And moveless fish in the water gleam,
By silver reeds in a silver stream.

Walter de la Mare

The Moon in the Mountains

Here in the mountains the moon I love,
Hanging slight in a distant grove;
Pitying me in my loneliness,
She reaches a finger and touches my dress.
   My heart resembles the moon;
   The moon resembles my heart.
My heart and the moon in each other delight,
Each watching the other throughout the long night.

E. D. Edwards

A Dream About the Man in the Moon

Into my head
When I went to bed
Came a dream as fine as silk,
And it took me away
As if in play
To a land as white as milk.

The milk grew thin
As I looked in.
I took another look,
The milk was gone,
I was alone
By a little crooked brook.

The trees were blue
The ducks said, "Hoo!"
The owls were taking a swim
A frog said, "Why
Is your skin so dry?"
But I ran away from him.

I came to a dew
As sweet and new
As birthdays on a cake.
So I took a drink
And what do you think
The dew became a lake!

I drank it dry
And hear it cry,
"I'm going, going, gone!"
"Thanks for the drink,"
I said, "I think
I had best be going on."

I ran till noon
And found the moon
Asleep in the top of a tree.
"What! Sleep all day?"
I stopped to say,
"Why don't you shine?" Said he:
"I shine for the owl, I shine for the bat.
I shine for the fox. I shine for the cat.
I shine for the rabbits that dance in the dew.
What makes you think I should shine for you?

I shine for the sea, I shine for the land.
I shine for the frogs when they strike up the band,
As they sit in the water all in a line.
Now you tell me - for whom do *you* shine?

I shine when the night-things come out of their den
I shine for the fire-flies. I shine then
For the dogs in the yard and the mice in the hall.
When do *you* shine - if you shine at all?"

John Ciardi

The Man in the Moon

The man in the Moon
As he sails in the sky
Is a very remarkable skipper.
But he made a mistake
When he tried to take
A drink of milk from the Dipper.
He dipped right into the Milky Way
And slowly and carefully filled it.
The Big Bear growled
And the Little Bear howled,
And frightened him so he spilled it.

Mother Goose

Summer Moonlight

The room looks strange when moonlight falls,
Across the windows and the walls,
The mirror frames a thousand stars,
The floor is ribbed with silver bars.

Around the panes the roses trail,
Their phantom blossoms, cool and pale.
The tree whose branches touch the sill,
Stands breathless, watching, very still.

I lie in silence, wide awake,
Afraid to stir lest I should break
The spell that is upon the night,
The peace of shadow and of light.

Patience Strong

On Summer Nights

Insects hover round our light
On summer nights in June:
I often wonder if they fly
Like that around the moon.

Aileen Fisher

The Moon in the Water

The moon in the water
turned a somersault
and floated away.

Ryota

Milk-White Moon Put the Cows to Sleep

Milk-white moon, put the cows to sleep.
Since five o'clock in the morning,
Since they stood up out of the grass,
Where they slept on their knees and hocks,
They have eaten grass and given their milk,
And kept their heads and teeth at the
   earth's face.
Now they are looking at you, milk-white moon.
Carelessly as they look at the level landscapes,
Carelessly as they look at a pail of new white milk,
They are looking at you, wondering not at all, at all,
If the moon is the skim face top of a pail of milk,
Wondering not at all, carelessly looking
Put the cows to sleep, milk-white moon,
Put the cows to sleep.

Carl Sandburg

Big Beautiful Moon

Big beautiful moon
   I can see you tonight,
As I lie on my cot
   And have put out the light.

Oh! *beautiful moon*,
   As you look on our earth
You can see many people
   Of high and low birth.

Please take them a message,
   A message from me,
As they see the same moon
   Far over the sea.

Oh, tell them God loves them
   That He died for them too.
May God bless them now,
   While I'm whispering to you.

In the faraway countries
   Where they know not God's love,
Tell all the dear children
   Of the true God Above.

Mrs. Louis Nadeau

The Moon

The moon has a face like the clock in the hall;
She shines on thieves on the garden wall,
On streets and fields and harbour quays,
And birdies asleep in the forks of the trees.

The squalling cat and the squeaking mouse,
The howling dog by the door of the house,
The bat that lies in bed at noon,
All love to be out by the light of the moon.

But all of the things that belong to the day
Cuddle to sleep to be out of her way,
And flowers and children close their eyes
Till up in the morning the sun shall arise.

Robert Louis Stevenson

My Wish

When the moon comes peeping through my windowpane at night,
I wish I had it on a string, that ball of silver light
To fly it like a kite above the houses in the Square,
Wouldn't it be fun to see the people stop and stare.

One gets tired of snakes-and-ladders, tricycles and tops,
Hunting robbers in the woods and munching acid drops,
This is what I keep on wishing. More than anything,
I'd like to walk to London with the moon upon a string.

Patience Strong

Moonlight

Like a white cat
Moonlight peers through the windows,
Listening, watching,
Like a white cat it moves
Across the threshold
And stretches itself on the floor;
It sits on a chair
And puts white paws on the table.
Moonlight crouches among shadows,
Watching, waiting
The slow passing of the night.

Maude E. Uschold

The Wind and the Moon

Said the Wind to the Moon, "I will blow you out;
   You stare
   In the air
   Like a ghost in a chair,
Always looking what I am about -
I hate to be watched; I'll blow you out."

The Wind blew hard, and out went the Moon.
   So, deep
   On a heap
   Of clouds to sleep,
Down lay the Wind, and slumbered soon,
Muttering low, "I've done for that Moon."

He turned in his bed; she was there again!
   On high
   In the sky,
   With her one ghost eye,
The Moon shone white and alive and plain.
Said the Wind, "I will blow you out again."

The Wind blew hard, and the Moon grew dim,
   "With my sledge,
   And my wedge,
   I have knocked off her edge!
If only I blow right fierce and grim,
The creature will soon be dimmer than dim."

He blew and he blew, and she thinned to a thread,
   "One puff
   More's enough
   To blow her to snuff!
One good puff more where the last was bred,
And glimmer, glimmer, glum will go the thread."

He blew a great blast, and the thread was gone,
   In the air
   Nowhere
   Was a moonbeam bare;
Far off and harmless the shy stars shone -
Sure and certain the Moon was gone!

The Wind he took to his revels once more;
   On down,
   In town,
   Like a merry-mad clown,
He leaped and halloed with whistle and roar -
"What's that?" The glimmering thread once more!

He flew in a rage - he danced and blew;
But in vain
Was the pain
Of his bursting brain;
For still the broader the Moon-scrap grew,
The broader he swelled his big cheeks and blew.

Slowly she grew - til she filled the night,
And shone
On her throne
In the sky alone,
As matchless, wonderful, silvery light,
Radiant and lovely, the queen of the night.

Said the Wind: "What a marvel of power am I!
With my breath,
Good faith!
I blew her to death--
First blew her away right out of the sky -
Then blew her in; what strength have I!"

But the Moon she knew nothing about the affair;
For high
In the sky,
With her one white eye,
Motionless, miles above the air,
She had never heard the great Wind blare.

George Macdonald

The Moon-Sheep

The moon seems like a docile sheep,
She pastures while all people sleep;
But sometimes, when she goes astray,
She wanders all alone by day.

Up in the clear blue morning air
We are surprised to see her there,
Grazing in her woolly white,
Waiting the return of night.

When dusk lets down the meadow bars
She greets again her lambs, the stars!

Christopher Morley

The Cat and the Moon

The cat went here and there
And the moon spun round like a top,
And the nearest kin of the moon,
The creeping cat, looked up,
Black Minnaloushe stared at the moon,
For, wander and wail as he would,
The pure cold light in the sky
Troubled his animal blood.
Minnaloushe runs in the grass
Lifting his delicate feet,
Do you dance, Minnaloushe, do you dance?
When two close kindred meet,
What better than call a dance?
Maybe the moon may learn,
Tired of that courtly fashion,
A new dance turn.
Minnsloushe creeps through the grass
From moonlit place to place,
The sacred moon overhead
Has taken a new phase.
Does Minnaloushe know that his pupils
Will pass from change to change,
And that from round to crescent,
From crescent to round they range?
Minnaloushe creeps through the grass
Alone, lifts to the changing moon
His changing eyes.

W. B. Yeats

The Moon

When its rays fall on its cheeks the cat licks them, thinking them milk;
When they are caught in the cleft of a tree the elephant deems them a lotus;
When they rest on the couch of lovers the maiden seizes them, saying, "'Tis my robe,"
The moon in truth, proud of its brilliance, doth lead astray all this world.

A. Berriedale Keith

The Moon's the North Wind's Cooky

The Moon's the North Wind's cooky.
He bites it, day by day,
Until there's but a rim of scraps
That crumble all away.

The South Wind is a baker.
He kneads clouds in his den,
And bakes a crisp new moon that ... greedy
North ... Wind ... eats ... again!

Vachel Lindsay

Mr. Moon

Mr. Moon
A Song of the Little People

O Moon, Mr. Moon,
When you comin' down?
Down on the hilltop,
Down in the glen,
Out in the clearin',
To play with little men?
Moon, Mr. Moon,
When you comin' down?

O Moon, Mr. Moon,
When you comin' down?
Down where the Good Folk
Dance in the ring,
Down where the Little Folk
Sing?
Moon, Mr. Moon,
When you comin' down?

Bliss Carman

Day-Time Moon

In the morning when the sun
Is shining down on everyone
How strange to see a daytime moon
Floating like a pale balloon
Over house and barn and tree
Without one star for company.

Dorothy Aldis

Moon, So Round and Yellow

Moon, so round and yellow,
Looking from on high,
How I love to see you
Shining in the sky.

Oft and oft I wonder,
When I see you there,
How they get to light you,
Hanging in the air.

Where you go at morning,
When the night is past,
And the sun comes peeping,
O'er the hills at last.

Sometime I will watch you
Slyly overhead,
When you think I'm sleeping
Snugly in my bed.

Matthias Barr

Hey, Diddle, Diddle

Hey, Diddle, diddle!
The cat and the fiddle,
The cow jumped over the moon,
The little dog laughed
To see such sport,
And the dish ran away with the spoon.

Mother Goose

Is the Moon Tired

Is the moon tired? She looks so pale
Within her misty veil;
She scales the sky from east to west,
And takes no rest.
Before the coming of the night
The moon shows papery white;
Before the dawning of the day
She fades away.

Christina Rosetti

The Moon

O look at the moon!
She is shining up there!
O mother, she looks
Like a lamp in the air.

Last week she was smaller,
And shaped like a bow;
But now she's grown bigger,
And round as an O.
Pretty moon, pretty moon,
How you shine on the door,
And make it all bright
On my nursery floor!

You shine on my playthings
And show me their place,
And I love to look up
At your pretty bright face.

And there is a star
Close by you, and maybe
That small twinkling star
Is your little baby.

Eliza Lee Follen

Night and Morning

The morning sits outside afraid
Until my mother draws the shade;

Then it bursts in like a ball,
Splashing sun all up the wall.

And the evening is not night
Until she's tucked me in just right,
And kissed me and turned out the light.

Oh, if my mother went away
Who would start the night and day?

Dorothy Aldis

To the Sun

O Sun, when I stand in my green leaves,
   With my petals full of dew,
And you fare forth in your splendor,
   My blossoming heart looks to you.
When, on the red dawn throning,
   The world at your feet you view,
Forget not the little flower
   That waits and watches for you!

O Sun, you that climb never tired
   The lofty paths of the skies,
My leaves, that open to see you,
   Follow you as you rise....
Come and seek out my heart and find it,
   For you it lives and dies!
It waits for you, it loves you...
   O my Bridegroom from Paradise!

And when in the evening the dark comes,
   When you haste to the welcoming West,
I watch your last beams fading,
   I see you sink down to rest.
With my head bowed I weep till the morning,
   Forsaken and distressed,
Come back, my Beloved, I am waiting
   To rise up and be caressed!

Jethro Bitell

The Sun is First to Rise

Up in the morning early,
The sun is first to rise;
The little birds begin to sing,
The farmers rub their eyes.
The rabbits hop down roads of dew,
The newborn baby cries,
And the gray kitten runs and leaps,
Chasing white butterflies.

Away to bed with darkness
The sun is first to go;
Across the fields with heavy wings
There flaps a shiny crow;
The children put away their toys,
Their steps are dragging slow;
And in the woods the spotted fawn
Lies close beside the doe.

Elizabeth Coatsworth

The Evening Sun

The evening sun was sinking down
   On low green hills and clustered trees;
It was a scene as fair and lone
   As ever felt the soothing breeze.

That cools the grass when day is gone,
   And gives the waves a brighter blue,
And makes the soft white clouds sail on--
   Like spirits of ethereal dew.

Which all the morn had hovered o'er
   The azure flowers, where they were nursed,
And now return to Heaven once more,
   Where their bright glories shone at first.

Emily Bronte

Sunset

A little pink feather
of sunset sat
right on top
of a hill's green hat.

Aileen Fisher

The Sun

Although it is gold,
   It isn't a locket;
Though shaped like a coin,
   It fits not a pocket.

It hasn't a ladder,
   But it can climb.
It's much like a clock
   For telling time.

It gives itself, free,
   To child and man,
But nobody touches it.
   Nobody can.

Leland Jacobs

The Sun

When the sun is drowsy
You can only see an inch,

When the sun is sleeping
You can only see a PINCH!

When the sun is waking
You can see across the hill,

And when it's strolling in the sky
You can see much farther still.

Aileen Fisher

The Sun

I told the Sun that I was glad,
   I'm sure I don't know why:
Somehow the pleasant way he had
   Of shining in the sky,
Just put a notion in my head
   That wouldn't it be fun
If, walking on the hill, I said
"I'm happy," to the Sun.

John Drinkwater

Any Sunset

There's something about the going down of the sun,
Whether it makes a bonfire of a cloud,
Or, too obscure and lonely to be proud,
Sinks on the nearest rooftop, and is gone,
There's something, not of color nor of size,
In the mere going, in the calm descent,
Half out of heaven and half imminent;
Final, as though it never again would rise.
There's something in it very noiselessness,
Unlike mad waters or the winds that shout
Their end in one last agony of excess;
Something that does not count its days nor deeds,
But thrusts itself to darkness and goes out
And finds whatever after-life it needs.

Louis Untermeyer

Summer Sun

Great is the sun, and wide he goes
Through empty heavens without repose;
And in the blue and glowing days
More thick than rain he showers his rays.

Though closer still the blinds we pull
To keep the shady parlor cool,
Yet he will find a chink or two
To slip his golden fingers through.

The dusty attic spider-clad
He, through the keyhole, maketh glad;
And through the broken edge of tiles
Into the laddered hay-loft smiles.

Meantime his golden face around
He bares to all the garden ground
And sheds a warm and glittering look
Among the ivy's inmost nook.

Above the hills, along the blue,
Round the bright air with footing true,
To please the child, to paint the rose,
The gardener of the World, he goes.

Robert Louis Stevenson

Merry Sunshine

"Good morning, Merry Sunshine,
How did you wake so soon,
You've scared the little stars away
And shined away the moon.

I saw you go to sleep last night
Before I ceased my playing;
How did you get 'way over there?
And where have you been staying?"

"I never go to sleep, dear child,
I just go round to see
My little children of the east,
Who rise and watch for me.

I waken all the birds and bees
And flowers on my way,
And now come back to see the child
Who stayed out late to play."

Anonymous

Sunrise and Sunset

I'll tell you how the sun rose,
A ribbon at a time,
The steeples swam in amethyst,
The news like squirrels ran.

The hills untied their bonnets,
The bobolinks begun.
Then I said softly to myself,
"That must have been the sun!"

But how he set, I know not,
There seemed a purple stile
Which little yellow boys and girls
Were climbing all the while.

Till when they reached the other side,
A dominie in gray
Put gently up the evening stars,
And led the flock away.

Emily Dickinson

An Indian Summer on the Prairie

In the Beginning

The sun is a huntress young,
The sun is a red, red joy;
The sun is an Indian girl
Of the tribe of the Illinois.

Mid-Morning

The sun is a smoldering fire
That creeps through the high gray plain,
And leaves not a bush of cloud,
To blossom with flowers of rain.

Noon

The sun is a wounded deer
That treads pale grass in the skies,
Shaking his golden horns,
Flashing his baleful eyes.

Sunset

The sun is an eagle old;
There is the windless west
Atop of the spirit-cliffs,
He builds him a crimson nest.

Vachel Lindsay

Prayer to the Sun God

Sunshine, forever
Fall on the mountain,
Gift of the Sun God.

Hide not your seeing,
Eye of the Day-Dawn,
Shine on forever.

Let me remember,
In my warm shelter
Peacefully lying.

Shine on me forever,
Light of the Sun God,
Peacefully falling.

Louis Martins

STARS

Ursa Major

Slung between the homely poplars at the end
of the familiar avenue, the Great
Bear in its slighted hammock swings,
like a neglected gate that neither bars admission nor invites,
hangs on the sagging pole its seven-pointed shape.

Drawn with the precision of an unknown problem
solved in the topmost classroom of the empty sky,
it demonstrated upon the inky blackboard of the night's
immeasurable finity the focal point of light.
For though the pointers seem to indicate the pole,
each star looks through us into outer space
from where the sun that burns behind and past us
animates immediately each barren, crystal face
with ravaged brilliance, that our eyes
must lean out into time to catch, and die in seeing.

James Kirkup

The Falling Star

I saw a star slide down the sky,
Blinding the north as it went by,
Too lovely to be bought or sold,
Too burning and too quick to hold,
Good only to make wishes on
And then forever to be gone.

Sara Teasdale

The Starlighter

When the bat's on the wing and the bird's in the tree,
Comes the old Starlighter, whom none may see.

First in the West where the low hills are,
He touches his wand to the Evening Star.

Then swiftly he runs on his rounds on high
Till he's lit every lamp in the dark blue sky.

Arthur Guiterman

My Star

All that I know
  Of a certain star
Is, it can throw
  (Like an angled spar)
Now a dart of red,
  Now a dart of blue;
Till my friends have said
  They would fain see, too,
My star that dartles the red and the blue!

Then it stops like a bird; like a flower, hangs furled:
  They must solace themselves with the Saturn above it,
What matter to me if their star is a world?
  Mine has opened its soul to me; Therefore I love it.

Robert Browning

Shooting Stars

When stars get loosened
in their sockets,
they shoot off through
the night like rockets.
But though I stay
and search where they
have seemed to slip,
I never yet have found a CHIP
TO CARRY IN MY POCKETS.

Aileen Fisher

Stars

Wouldn't
you
think

Little
stars
might

Get
very
tired

Staying
up all
night?

Aileen Fisher

Away from Town

Away from the street lights,
away from town,
stars are more shiny
and hang more down.

Out in the country
where spaces grown,
stars are more many
and hang more low.

Aileen Fisher

Evening Walk

The stars were shining merrily,
A silver eye, each one,
And when I ran they followed me,
So then I didn't run.
I held my mother's hand instead,
But later when I lay in bed,
They winked at me inside my head.

Dorothy Aldis

February Twilight

I stood beside a hill
   Smooth with new-laid snow,
A single star looked out
   From the cold evening glow.

There was no other creature
   That saw what I could see--
I stood and watched the evening star
   As long as it watched me.

Sara Teasdale

The Pleiades

"Who are ye with clustered light,
   Little Sisters seven?"
"Crickets, chirping all the night
   On the hearth of heaven."

John Banister Tabb

Stars

If to the heavens you lift your eyes
When Winter reigns o'er the Northern skies,
And snow-cloud none the zenith mars,
At Yule-tide midnight these your stars:
Low in the South see bleak-blazing Sirius;
Above him hang Betelgeuse, Procyon wan;
Wild-eyed to West of him, Rigel and Bellatrix,
And rudd-red Aldebaren journeying on.
High in night's roof-tree beams twinkling Capella;
Vega and Deneb prowl low in the North;
Far to the East roves the Lion-heart, Regulus;
While the twin sons of Zeus to'rd the Zenith gleam forth.

But when Midsummer Eve in man's sleep-drowsed hours
Refreshes for daybreak its dew-bright flowers,
Though three of these Night Lights aloft remain,
For nine, if you gaze , you will gaze in vain.
Yet comfort find, for, far-shining there,
See golden Arcturus and cold Altair;
Crystalline Spica, and, strange, to scan,
Blood-red Antares, foe to Man.

Walter de la Mare

Stars

Now in the West the slender moon lies low,
And now Orion glimmers through the trees,
Clearing the earth with even pace and slow,
And now the stately-moving Pleiades,
In that soft infinite darkness overhead
Hang jewel-wise upon a silver thread.

And all the lonelier stars that have their place,
Calm lamps within the distant southern sky,
And planet-dust upon the edge of space,
Look down upon the fretful world, and I
Look up to outer vastness unafraid
And see the stars which sang when earth was made.

Marjorie Pickthall

Silver Sheep

The sun's a bright-haired shepherd boy,
Who drives the stars away;
Beyond the far blue meadows
He shuts them up by day.

At six or seven or eight o'clock,
Over the bars they leap -
The rams with horns of silver,
The little silver sheep.

And while the shepherd takes a nap
Behind a hill, near-by,
They roam the dusky pasture
And graze upon the sky.

Anne Blackwell Payne

Escape at Bedtime

The lights from the parlour and kitchen shone out
   Through the blinds and the windows and bars;
And high overhead and all moving about,
   There were thousands of millions of stars.

There ne'er were such thousands of leaves on a tree,
   Nor of people in church or the Park,
As the crowds of the stars that looked down upon me,
   And that glittered and winked in the dark.

And Dog, and the Plough, and the Hunter, and all,
   And the star of the sailor, and Mars,
These shone in the sky, and the pail by the wall
   Would be half full of water and stars.

They saw me at last, and they chased me with cries,
   And they soon had me packed into bed;
But the glory kept shining and bright in my eyes,
   And the stars going round in my head.

Robert Louis Stevenson

The Little Star

Twinkle, twinkle, little star,
How I wonder what you are;
Up above the world so bright,
Like a diamond in the night.

When the blazing sun is gone,
When he nothing shines upon,
Then you show your little light,
Twinkle, twinkle, all the night.

Then the traveller in the dark,
Thanks you for your tiny spark;
He would not tell which way to go
If you did not twinkle so.

In the dark blue sky you keep
And often through my curtains peep,
Till the sun is in the sky,
As your bright and tiny spark
Lights a traveller in the dark,
Though I know not what you are,
Twinkle, twinkle, little star.

Jane Taylor

I Wonder

Boys:
I wonder if the stars are fire,
Girls:
Or if the stars are gold,
Solo:
And if a little one should drop,
All:
'T would burn my hand to hold?

Mrs. Schuyler Van Renssalaer

BALLOONS AND KITES

The Dirigible

The only real airship
   That I've ever seen
Looked more like a fish
   Than a flying machine.

It made me feel funny,
   And just as if we
Were all of us down
   On the floor of the sea.

A big whale above us
   Was taking a swim,
And we little fishes
   Were staring at him.

Ralph W. Bergengren

My Kite

Solo I:
The busy wind is out today
All:
A-blowing all the clouds away
Boys:
And chasing butterflies and bees
Girls:
And making music in the trees
Solo 2:
My kite it carries far and high
All:
Till it is lost up in the sky.

Barbara and Beatrice Brown

Fly Away, Kite!

K was a kite
Which flew out of sight,
Above houses so high,
Quite into the sky.

Edward Lear

A Kite

I often sit and wish that I
Could be a kite up in the sky,
And ride upon the breeze and go
Whichever way I chanced to blow.

Author unknown

There was an Old Man of the Hague,
Whose ideas were excessively vague,
He built a balloon to examine the moon,
That deluded Old Man of the Hague.

Edward Lear

AIR TRAVEL

Riding in an Airplane

Azzoomm, azzoomm loud and strong --
Azzoomm, azzoomm a steady song --
   And UP I went
   UP and UP
      For a ride
      In an airplane.

The machinery roarrrred
And whirrred
And jiggled my ears
Yet I
Just sat right
On a chair
Inside that airplane
And made myself
Stare
Out of a window.

There
Way down below
I saw autos
Scuttling along.
   They looked to me
   Like fast little lady bugs --
   So small!
And I saw houses
That seemed to be
   Only as big as match boxes --
   That's all!

But the strangest sight
Was when
We came to some clouds!
We stared down
Instead of up
To see them.
   And they looked
Like puffs of smoke
From giant cigarettes.

Dorothy W. Baruch

"A"

A is for the Aeroplane.
   Ah, watch it soar and sail!
It likes to carry passengers,
   It loves to carry mail.
And sometimes in the afternoons,
   It's apt to advertise
And writing amusing messages
   Across the city skies.

Phyllis McGinley

Aeroplane

There's a humming in the sky
There's a shining in the sky
Silver wings are flashing by
Silver wings are shining by
Aeroplane
Aeroplane
Flying -- high.

Silver wings are shining
As it goes gliding by
First it zooms
And it booms
Then it buzzes in the sky
Then its song is just a drumming
A soft little humming
Strumming
Strumming.

The wings are very little things
The silver shine is gone
Just a little black speck
Away down the sky
With a soft little strumming
And a far-away humming
Aeroplane
Aeroplane
Gone -- by.

Mary McBride Green

Wilbur Wright and Orville Wright

Said Orville Wright to Wilbur Wright,
"These birds are very trying.
I'm sick of hearing them cheep-cheep
About the fun of flying.
A bird has feathers, it is true,
That much I freely grant,
But, must that stop us, 'W'"?
Said Wilbur Wright, "It shan't."

And so they built a glider, first,
And then they built another.
- There never were two brothers more
Devoted to each other.
They ran a dusty little shop
For bicycle repairing
And bought each other soda-pop
And praised each other's daring.

They glided here, they glided there,
They sometimes skinned their noses,
- For learning how to rule the air
Was not a bed of roses.
But each would murmur, afterward,
While patching up his bro
"Are we discouraged, 'W'"?
"Of course we are not, 'O'!"

And finally, at Kitty Hawk
In nineteen-three (let's cheer it!),
The first real airplane really flew
With Orville there to steer it!
- And kingdoms may forget their kings
And dogs forget their bites,
But, not till Man forgets his wings,
Will men forget the Wrights.

Rosemary and Stephen Benet

Be like the bird, who
Halting in his flight
On limb too slight
Feels it give way beneath him,
Yet sings
Knowing he hath wings.

Victor Hugo

Night Plane

The midnight plane with its riding lights
looks like a footloose star
wandering west through the blue-black night
to where the mountains are,

a star that's journeyed nearer earth
to tell each quiet farm
and little town, "Put out your lights,
children of the earth. Sleep warm."

Frances Frost

High Flight

Oh, I have slipped the surly bonds of earth,
And danced the skies on laughter-silvered wings;
Sunward I've climbed and joined the tumbling mirth
Of sun-split clouds - and done a hundred things
You have not dreamed of - wheeled and soared and swung
High in the sunlit silence, hov'ring there,
I've chased the shouting wind along and flung
My eager craft through footless halls of air.
Up, up the long delirious, burning blue
I've topped the wind-swept heights with easy grace
Where never lark, or even eagle, flew;
And, while with silent, lifting mind I've trod
The high untrespassed sanctity of space,
Put out my hand, and touched the face of God.

John Gillespie Magee, Jr.

Taking Off

The airplane taxis down the field
And heads into the breeze,
It lifts its wheels above the ground,
It skims above the trees.
It rises high and higher,
Away up toward the sun,
It's just a speck against the sky
-- And now it's gone!

Author unknown

Flight

They are immortal, voyagers like these,
Bound for supreme and royal latitudes;
They soar beyond the eagle, where it broods,
With Venus and the evening Pleiades;
For in the pale blue Indies of the sky,
They plough. gold-prowed, the Arteries of Air,
Finding an unexplored dimension there --
They leave us Star Maps we may voyage by.

Not Galileo, with his dreaming power,
Not great Columbus, master of the gale,
Chartered for Time such harbors for man's flight.
Lured by another Odyssey, a Grail,
They climbed the heavens. Byrd in his white hour,
Lindbergh,an eagle sweeping through the night.

Harold Vinal

Wings and Wheels

Ahoy and ahoy, birds,
We cannot have wings
And feathers and things,
But dashing on wheels
With the wind at our heels
Is almost like flying --
Such joy, birds!

Oho and oho, birds,
Of course we can't rise
Up and up to the skies;
But skimming and sliding,
On rollers, and gliding,
Is almost as jolly
You know, birds!

Nancy Byrd Turner

There goes an airplane, racing up high
In big clouds and small clouds that float in the sky.
I'd like to be up there and look down at the ground
And pilot the airplane in loops, round and round.

Zhenya Gay

Up in the Air

Zooming across the sky,
Like a great bird you fly,
   Airplane,
   Silvery white
   In the light.

Turning and twisting in air,
When shall I ever be there,
   Airplane,
   Piloting you
   Far in the blue?

James S. Tippett

The Airplane

An airplane has gigantic wings
But not a feather on her breast;
She only mutters when she sings
And builds a hangar for a nest.
I love to see her stop and start;
She has a little motor heart
That beats and throbs and then is still.
She wears a fan upon her bill.

No eagle flies through sun and rain
So swiftly as an airplane.
I wish she would come swooping down
Between the steeples of the town
And lift me right up off my feet
And take me high above, the street.
That all the other boys might see
The little speck that would be me.

Rowena Bastin Bennett

Cockpit in the Clouds

Two thousand feet beneath our wheels
The city sprawls across the land
Like heaps of children's blocks outflung,
In tantrums, by a giant hand.
To east a silver spire soars
And seeks to pierce our lower wing.
Above its grasp we drift along,
A tiny, droning, shiny thing.

The noon crowds pack the narrow streets,
The el trains move so slow, so slow,
Amidst their traffic, chaos, life,
The city's busy millions go.
Up here, aloof, we watch them crawl.
In crystal air we seem to poise
Behind our motor's throaty roar --
Down there, we're just another noise.

Dick Dorrance

Fairy Aeroplanes

The fairies, too, have aeroplanes
To carry them about.
That swoop, and soar, and dart, and dip,
And circle in and out.

So when their little wings are tired,
They summon one of these.
And sail above the garden beds
Or anywhere they please.

The fairies' aeroplanes are safe
And never do capsize.
They're very beautiful and gay,
Because they're butterflies.

Annie Blackwell Payne

Silver Ships

There are trails that a lad may follow
   When the years of his boyhood slip,
But I shall soar like a swallow
   On the wings of a silver ship,

Guiding my bird of metal,
   One with her throbbing frame,
Floating down like a petal,
   Roaring up like a flame;

Winding the wind that scatters
   Smoke from the chimney's lip,
Tearing the clouds to tatters
   With the wings of a silver ship;

Grazing the broad blue sky light
   Up where the falcons fare,
Riding the realms of twilight,
   Brushed by a comet's hair;

Snug in my coat of leather,
   Watching the skyline swing,
Shedding the world like a feather
   From the tip of a tilted wing.

There are trails that a lad may travel
   When the years of his boyhood wane,
But I'll let a rainbow ravel
   Through the wings of my silver plane.

Mildred Plew Meigs

SPACE TRAVEL

The City

The airman deals in geography.
Geography is the mother of the old cities.
Immemorially earthbound, men have linked their lives
where land and sea have blended most happily;
where deep rivers have made confluence;
or at crossings of strategic trails.

During the centuries the great cities
exercised authority over civilization -
social, political, economic, spiritual.
And in the first half-century of flight,
the airplane bowed to the pattern of Piccadilly
and Times Square and the Piazza Venzia
and the Puerto del Sol and the Bund.
To make one street of the Avenue des Champs-Elysees
and Michigan Avenue and Avenida Beira Mar
seemed enough. And it was enough
so long as the airman's trail led along
the nearer shore of the air ocean,
where the winds and storms and fogs of the
   lower atmosphere
beat like surf against the globe.

But it is no longer enough.
The airplane is launching now
on the farthest reaches of the air ocean
above the vagaries of the atmosphere.
More and more it overlows even the mightiest cities
to follow great circle courses
to global destinations.

The need is gone to circumvent broad seas
and desert wastes and arctic ice.
The old cities have lost their unshakable authority
over the destiny of man.
They totter in stature before the logic of the air age.
In vain they spend their substance
in the loved features of their obsolescence.
In vain they relegate the facilities
of the air age to their outermost limits.

In the rolling years their accustomed stature
will recede. The air age will build new cities
nearer to it's heart's desire.
The old city is a target, not of the atom bomb,
but of the airman's geography.
Some day in the far future, a pilot,
noting the position of his aircraft in space,
will say to his passengers over the microphone,
"Beneath us at this point
lies one of the seven wonders of the earthbound age,
the ruins of New York.
The city was never under military attack,
and many features are well preserved."

Gil Robb Wilson

The Silver Spaceship

All aboard the silver spaceship!
   It will take off very soon.
All the passengers are ready
   Now the trip starts for the moon.

Up it goes so high, high, high,
   Like a bullet in the sky.
Up, up, up,
   And away!

Rene G. Varlay

from Reply to Mr. Wordsworth

Space-time, our scientists tell us, is impervious.
It neither evades nor refuses. It curves
As a wave will or a flame - whatever's fervent.

Space-time has no beginning and no end.
It has no door where anything can enter.
How break and enter what will only bend?

Archibald MacLeish

Space Travel

It's all aboard for outer space
Straight up from my home town
I'll board the rocket going up
And hope it will come down.

I'll bet when there, the sun will rise
Just as I go to bed
And it will set when I get up
Not as it should, instead.

And will I know when weather's wet
And know when it is dry?
Can it rain up, as well as down,
When you are up that high?

I only have a few requests
Of Spacemen up on Mars,
May I roll out the morning sun
And hang the evening stars?

And may I hail a floating cloud
And ride it for a day?
And could I have a motel room
Along the Milky Way?

Will outer space be better still
Than here, where I live now?
Will I find things I like to eat,
And can I play -- and how?

If you can find the answer
To my queries very soon,
Then make my reservation
On a rocket to the moon.

Jane V. Krows

Interplanetary Limerick

A Martian named Harrison Harris
Decided he'd like to see Paris;
In space (so we learn)
He forgot where to turn -
And that's why he's now on Polaris.

Al Graham Brewton

Little Satellite

Once a little satellite
Reached a most unheard of height,
Far in space it soared and soared
Around the moon it roared and roared.

Like a spinning, whirling base
Orbiting around in space
Beeping, beeping all its worth
Messages sent back to earth.

What a trip for one so small
Little satellital ball,
Do you wish for earth again,
When you're whirling in your spin?

Will you solve the mystery soon
Of outer space and of the moon?
I would only soar from sight
If I could return each night.

Jane W. Krows

The Infinite

This lonely hill has always
Been dear to me, and this thicket
Which shuts out most of the final
Horizon from view. I sit here,
And gaze, and imagine
The interminable spaces
That stretch away, beyond my mind,
Their uncanny silences,
Their profound calms; and my heart
Is almost overhwelmed with dread.
And when the wind drones in the
Branches, I compare its sound
With that infinite silence;
And I think of eternity,
And the dead past, and the living
Present, and the sound of it;
And my thought drowns in immensity;
And shipwreck is sweet in such a sea.

Giacomo Leopardi

Among the Stars

(Note: Long before anyone thought seriously of space-travel William Wordsworth imagined a trip in a flying ship that took him beyond the stratosphere. It was in 1798 that he wrote the long narrative poem Peter Bell, from which "Among the Stars" is taken. Even at that time, Wordsworth suggested that Mars was inhabited by a "Red-haired race," that Jupiter was full of forests, and that there were towns on Saturn. But nothing found among the stars could compare with the green globe of Earth, and the space-traveler returned home with a rush of delight)

There's something in a flying horse,
There's something in a huge balloon;
But through the clouds I'll never float
Until I have a little boat,
Shaped like a crescent moon.

And now I have a little boat,
In shape a very crescent moon;
Fast through the clouds my boat can sail;
And if perchance your faith should fail,
Look up - and you shall see me soon!

The woods, my friends, are round you roaring,
Rocking and roaring like a sea;
The noise of danger's in your ears,
And ye have all a thousand fears,
Both for my little boat and me!

Meanwhile untroubled I admire
The pointed horns of my canoe;
And, did not pity touch my breast
To see how ye are all distrest,
Till my ribs ached, I'd laught at you!

Away we go, my boat and I
Frail man ne'er sat in such another;
Whether among the winds we strive,
Or deep into the clouds we dive,
Each is contented with the other.

Away we go - and what care we
For treason, tumults, and for wars?
We are as calm in our delight
As is the crescent moon so bright
Among the scattered stars.

Up goes my boat among the stars
Through many a breathless field of light,
Through many a long blue field of ether,
Leaving ten thousand stars beneath her;
Up goes my little boat so bright!

The Crab, the Scorpion, and the Bull -
We pray among them all; have shot
High o'er the red-haired race of Mars,
Covered from top to toe with scars,
Such company I like it not!

The towns of Saturn are decayed,
And melancholy spectres throng them;
The Pleiades, that appear to kiss
Each other in the vast abyss,
With joy I sail among them.

Swift Mercury resounds with mirth,
Great Jove is full of stately bowers;
But these, and all that they contain,
What are they to that tiny grain,
That little Earth of ours?

Then back to Earth, the dear green Earth;
Whole ages if I here should roam,
The world for my remarks and me
Would not a whit the better be,
I've left my heart at home.

See: There she is, the matchless Earth!
There spreads the famed Pacific Ocean!
Old Andes thrusts yon craggy spear
Through the grey clouds; the Alps are here,
Like waters in commotion!

Yon tawny slip is Libya's sands;
That silver thread the river Dnieper;
And look, where clothed in brightest green
Is a sweet Isle, of isles the Queen;
Ye fairies, from all evil keep her!

And see the town where I was born!
Around those happy fields we span
In boyish gambols; I was lost
Where I have been, but on this coast
I feel I am a man.

Never did fifty things at once
Appear so lovely, never, never;
How tunefully the forest ring!
To hear the earth's soft murmuring,
Thus could I hang forever!

Man for Mars

Spaced in a helmet
now his head
still has a mouth
which must be fed,

still has two eyes
for looking round,
still has big ears
but little sound;

still has a nose
that runs a bit -
no spaceman blows or scratches it;

still has two hands
which he employs
in picking apples;

still enjoys
the heady smell
of autumn air -
especially heady
inside there.

Apples! Some wormy,
mostly beauties,
His inter -
planetary duties

over now, let
Mars and Cygnus -
X relax;
too much of bigness,

too much of all
this instellar
business tires
a busy feller.

Here is a barn
and here is sun;
a combination
darn good fun;

a spaceman's helmet
full of Macs
free oxygen
the cosmos lacks;

white teeth, and apple,
the heaven's dome,
and a hornet blasting
off for home.
David McCord

A Projection

I wish they would hurry up there to Mars,
Those rocket gentlemen.
We have been waiting too long; the fictions of little men
And canals,
And of planting and raising flags and opening markets
For beads, cheap watches, perfume and plastic jewelry -
All these begin to be tedious; what we need now
Is the real thing, a thoroughly bang-up voyage
Of discovery.

Led by Admiral Byrd
In the Nina, Pinta and Santa Maria
With a crew of one hundred experts
In physics, geology, war and creative writing,
The expedition should sail with a five-year supply of
Pemmican, Jello, moxie,
Warm woolen socks and jars of Gramm's preserves.

Think of them out there,
An ocean of space before them, using no compass,
Guiding themselves by speculative equations,
Looking,
Looking into the night and thinking now
There are no days, no seasons, time
Is only on watches,
And landing on Venus
Through some slight error,
Bearing

Proclamations of friendship,
Declarations of interstellar faith,
Acknowledgements of American supremacy,
And advertising matter.
I wonder,
Out in the pitch of space, having worlds enough,
If the walled-up, balled-up, self could from its alley
Sally.

I wish they would make provisions for this,
Those rocket gentlemen.

Reed Whittemore

Weather Satellites

Tiros and Nimbus way up in the sky
Taking pictures as you fly by.
Pictures of clouds, the directions they go
You can tell us when it's going to snow.

The weather man likes you, that's easy to see
You help him tell us what the weather will be,
And our farmers who raise our wheat, corn, and spuds
Are warned of possible droughts or floods.

Our great ships sailing from England and Spain
Are warned and can watch a great hurricane,
So keep right on working, you wonders of man
You're telling us much about our great land.

E. Cushman

Post Early for Space

Once we were wayfarers; then seafarers; then airfarers;
We shall be spacefarers soon,
Not voyaging from city to city or from coast to coast,
But from planet to planet and from moon to moon.

This is no fanciful flight of imagination,
No strange, incredible, utterly different thing;
It will come by obstinate thought and calculation
And the old resolve to spread an expanding wing.

We shall see homes established on distant planets,
Friends departing to take up a post on Mars;
They will have perils to meet, but they will meet them,
As the early settlers did on American shores.

We shall buy tickets later as now we buy them
For a foreign vacation. Reserve our seat of berth,
Then spending a holiday month on a moon of Saturn
Loom tenderly back to our little shining Earth.

And those who decide they will not make the journey
Will remember a son up there or a favorite niece,
Eagerly awaiting news from the old home planet,
And will scribble a line to catch the post for space.

Peter J. Hennicker-Heaton

They cross the ether now,
They travel on high frequencies
Over the border-lines and barriers
Of mountain ranges and oceans.
When shall we all speak the same language?
And do we want to have all the same?
Are we learning a few great signs and passwords?

Carl Sandburg

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